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LIFE HISTORY OF MOUNTAIN VISCACHAS IN PERU

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The only hystricomorph rodent that has been studied extensively is the guinea pig, and even it has been studied only in captivity. Information is accumulating slowly from captive chinchillas and nutrias, and the aberrant porcupines have long received attention, but surprisingly little is known of the rest of this group that contributes so generously to the fauna of South America. A desire to study one of them in the wild led to the work reported here. The abundance and ease of collection of viscachas made them a logical choice, although it must be confessed that the interesting fauna associated with them and a laboratory-nourished nostalgia for wild high mountains were also powerful inducements.

The first published record of mountain viscachas was in 1533 by Pedro de Cieca, a Spaniard who had traveled "seventeen years through the mighty kingdom of Peru." During the ensuing four centuries taxonomic literature on viscachas has undergone a stormy career, assuming, discarding, and sometimes reassuming generic names such as *Lepus*, Molina, *Lagotis* Bennett, *Viscaccia* Oken, *Callomys* D'Orbigny and Geoffroy St. Hilaire, *Lagostomus* (Wagler), and *Lagidium* Meyen with bewildering frequency. It is to be hoped that this checkered career has been terminated by Decision 110 of the International Commission on Zoological Nomenclature, which declared that *Lagidium* was henceforth to be the "official" generic name. Tate (1935) outlines this taxonomic history. Even the technical name *Lagidium* is not sacred, for Malaise (1933) has recently made use of it for a genus of hymenopteran insects.

The common Indian name for this animal when the Spaniards arrived in South America was huiscacha or uiscacha (Quechua and Aymara dialects), and the Spanish derivative, viscacha, has remained the most popular name ever since, although the following variations have appeared; vizcacha, viscache, viscaccia, viscacia, biscacha, biscacho, chinchille, Peruvian hare, and lagidium.

Another large hystricoid rodent, *Lagostomus*, of the pampas is also called viscacha. The ranges of the two animals do not overlap and the names mountain viscacha and plains viscacha may be used in cases where confusion might arise.

The mountain viscachas (*Lagidium*) and chinchillas (*Chinchilla*) are rather close relatives within the family Chinchillidae, whereas the plains viscachas are less closely related, but nevertheless in the same family. Ellerman (1940) quotes

Jennison (1929) as saying that chinchillas have bred with viscachas, but I have not been able to locate the latter reference. The guinea pig belongs to a separate family.

The subspecific determination of the viscachas of Peru is a difficult matter. The color of specimens from a single locality is extremely variable (Pl. II) and changes considerably with age—facts not fully realized by Thomas when he described five full species from Peru (see especially Thomas, 1907) and three from adjacent Bolivia. Many of these descriptions are brief, based on few specimens, and in all cases the types are in the British Museum. Until more topotypes are available I have chosen to follow the lead of Hayman (in Ellerman, 1940) who examined the specimens in the British Museum and concluded that all the Peruvian "species" should be considered subspecies of *L. peruanum* Meyen, the type locality of which, C. C. Sanborn informs me, was probably Pisacoma. This town is only fifty miles west of where most of my studies were carried out, and my specimens are probably *L. p. peruanum*.

Where they live.—Mountain viscachas range from central Peru (*Lagidium peruanum inca* and *subrosea*) down the Andes of Bolivia, Argentina, and Chile to, appropriately, Ultima Esperanza, about 52° S. latitude in Patagonia (*L. wolffsohni*), a range of nearly 2800 miles. Krumbiegel (1940) extends their range as far north as the equator, but he gives no definite records and I have found no author who corroborates this. Osgood (1914) found recently occupied burrows near Otuzco and heard reports of viscachas living near Cajamarca—locations about 300 miles north of the range of *inca* and *subrosea*.

Viscachas are considered the only Chilean mammals definitely characteristic of the Puna Zone of Osgood (1943), which is the region above timberline and below snowline. *L. boxi* lives as low as 2700 feet near the Rio Negro in Argentina, and several northern races are found above 16,000 feet. Twenty-one races have been described.

The range of *L. peruanum peruanum*, the subspecies under consideration, is imperfectly known, but this form probably inhabits much of the region between Tacna, Lake Titicaca, and Arequipa. Almost all of this region lies above 12,500 feet, the altitude of Lake Titicaca, and is a dry, mountainous country of grass and sage-like brush called tola. Trees grow only around habitations and in a single area of a few square miles near Santa Rosa in the Department of Puno, where *Polylepis tomentella* grows large enough (ten inches in diameter and fifteen feet tall) and abundantly enough to be cut commercially for firewood. The rolling farm country (potatoes, quinoa, corn, oats) and grazing land near the lake become more rugged, rocky, and dry to the west, culminating in stretches of sandy and rocky desert, jagged crests, steep cinder slopes, sulfur springs, and other signs of volcanic activity.

The viscacha may make his home any place in this region where there are rocks, water, and food—no rocks, no viscachas. Rocky cliffs and outcrops are acceptable if they have some deep crevices and narrow stony tunnels suitable as nesting sites, but if we may consider great numbers of viscachas as an indication of optimum living conditions, then the favorite habitat is a vast tumble

PLATE I

UPPER: An adult and an immature (about 1.7 pounds) viscacha. These and about three others lived in a den under the overhanging rocks.

LOWER: Two viscachas.

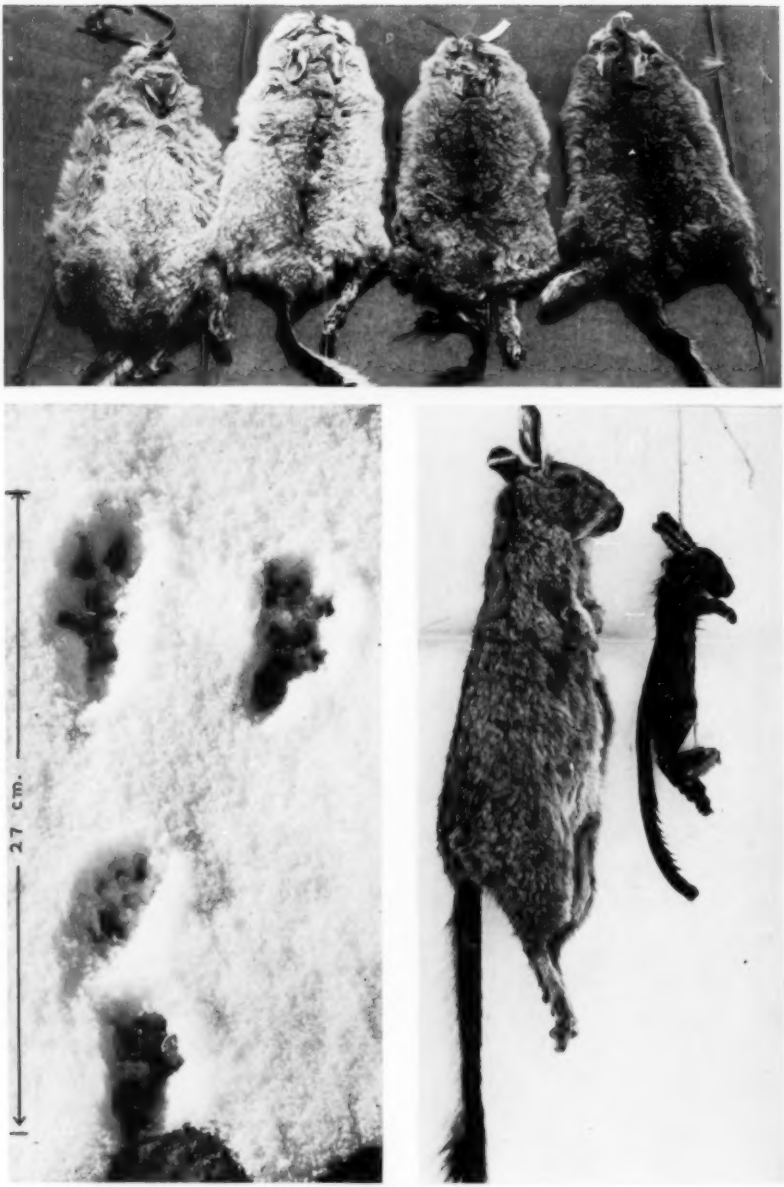

PLATE II

UPPER: Color variation of viscachas captured on the same hill.
LOWER LEFT: Viscacha tracks in light snow.
LOWER RIGHT: An adult viscacha and an almost full-term fetus with wet fur.

of boulders under which and in the crevices of which are many ready-made burrows, big enough in diameter for a man to reach into, but too deep for him to reach the end. Here a viscacha can escape from foxes by bounding with great agility from rock to rock, and if necessary by retreating into these burrows; and here are innumerable lookout and sunning perches on top of boulders. As often as not the best rocky slopes are on the sides of steep bowls or cirques where truck-sized fragments have plunged from the towering cliffs above to form a Herculean talus. The viscachas come down from the rocks to feed in the center of these bowls where a seep of water or ice may be marked by a green carpet of *Distichia*. The optimum altitude for viscachas is perhaps 15,000 to 16,000 feet. We found them at 17,000 feet, but not much above this.

Next to rocks in importance is water. Only rarely have I seen viscachas at a place where they had to cross more than fifty yards of open ground to get to water. In the wild they are not often seen drinking, and it is possible that the water itself is not as important as the ribbon of succulent green vegetation that it can support in this arid region. Captives, however, drank water or licked ice frequently.

There must be vegetation of course, but the kind of plants available does not seem to influence the choice of a homesite. The dominant vegetation near some of the viscacha colonies was tufted ichu grass, whereas at others grass was almost absent. The inedible, moss-like yareta (*Azorella yarita*), tola (*Lepidophyllum*, *Baccharis*, and *Senecio*), and spiny grass (*Festuca orthophylla*) were the dominant plants at the higher colonies. Lichens were the only plants common to all colonies. Another important factor determining where viscachas live is the presence of other viscachas. They never live alone.

We were never able to dig out and examine one of their permanent burrows (Pl. I, Upper) for these were always in cliffs or were too well protected by immovable boulders. Some were examined at night with a flashlight, but we never saw a nest of any sort. We could not see into all the corners, however. The floor was always fairly clean, frequently with broken vibrissae and a few scats lying about. Captive or wild viscachas were never seen carrying nesting material, and we have no evidence that females pluck fur to make a nest.

Material and methods.—I have observed viscachas in many places in southern Peru, but by far the greatest amount of field work was carried out from August 6 to December 13, 1946, at Caccachara, a valley first visited with the Gardner Peruvian Expedition from the Museum of Comparative Zoology in 1939. This spot was chosen for the study because it was the home of an unusually large number of viscachas that were relatively unaffected by man, and because vicunas and other interesting animals lived there and could be studied at the same time.

Viscachas were also studied at two locations between Caccachara and Santa Rosa; at Santa Rosa (14,000 ft.) from July 28 to August 6; and at Hacienda Pairumani (13,000 ft.) from December 21 to 26, 1939, and from July 14 to 27, 1946. All of these locations are in Peru in the Department of Puno. Material that I have collected from other locations in southern Peru is so fragmentary that I have not used it to any great extent in this work.

Four hundred and ninety-eight viscachas were examined. Three hundred and eighty-nine of these were shot, sixty-two were trapped alive and forty-seven live ones were bought from natives. Almost all of those shot were measured, weighed on a spring scale, and dissected as soon as they were brought into camp. The female reproductive organs were examined in situ and then were preserved in Bouin's fluid. In males the reproductive organs were examined, the testes were measured, and occasionally bits of testis and epididymis were preserved in Bouin's fluid. For use in determining age, we dried the baculum and one humerus from most of the males, and the skull and a humerus from most of the females. Other organs and parasites were preserved occasionally.

One hundred and nine viscachas were kept in captivity from one to fifty days. Many of these died, some were sacrificed, and thirty-six were marked and released. Using ether anesthesia and a"semi-sterile" surgical technique, laparotomies were performed on eleven males and thirty females. Twenty-two of the "patients" were marked (by ear-notching or toe-cutting) and released after their weights and the condition of the reproductive organs had been determined or after the removal of one ovary. Several of these released individuals were shot later in the season.

Serial sections of fifty-seven selected pairs of ovaries were cut at ten micra and stained with hematoxylin and eosin. All the male material was prepared in a similar fashion.

With my associates, George P. Gardner, Jr., Allen Enders, and Anita Pearson, I spent many hours observing colonies of viscachas. I have drawn on many of their observations—sometimes, I fear, without giving proper credit. I am also indebted to Dr. Francis Pennell, Dr. John Reeder, and Charlotte Reeder for identifying many plant specimens.

Caccachara.—Because so much of the work was carried out at Caccachara, I shall describe this region in some detail. Camp was made in a valley at 16,000 feet at the foot of 17,400–foot Cerro Ichuasi (16°41′ S. and 70°4′ W.) about five miles south of the continental divide. The valley is drained by a small river, the Rio Caccachara, which empties into the Pacific Ocean by way of the Rio Tambo. The town of Ilave, near Lake Titicaca, is fifty miles northeast of this valley. Caccachara can be reached on foot, by pack train, or, from April to December, by truck over an abominable road from Mazocruz on the Ilave–Tacna road. It is in a region of rugged mountains and a few rolling plains and flat valleys, but the relief is not great; the entire region is between 14,000 and 18,000 feet. The only detailed map of the region is the Carta Nacional, Departmento de Puno, titled Ylave, published by the Servicio Geografico, 1929. The altitudes I have given have been obtained partly from this and other maps, and partly from conversations with mining engineers and residents of the region.

The mountain slopes at Caccachara are pitted with numerous long-abandoned mine shafts (chiefly lead and zinc), some of which are said to have been dug during the reign of the Spaniards. There are a few stone huts and stone-walled corrals. Pack trains of llamas and burrows frequently passed through the valley and a truck passed by our camp every week or two on its way to the San Bosco

or Pavico mines, which are a few miles north of the continental divide. Only twice during our stay did other people spend the night in the valley within five miles of our camp. Natives consider the Caccachara valley cold and forlorn, although the climate is little different in neighboring valleys which have a few inhabitants.

One is impressed at first by the aridity of Caccachara and the sparseness of the vegetation. There are many patches of utterly barren sand and rock, but on most of the lower mountain slopes grow scattered clumps of the blue-gray, spiny grass (*Festuca orthophylla*), a few scattered tola bushes (*Lepidophyllum*), and a few yellow-green mats of the moss-like *Pycnophyllum aculeatum*. None of these reach two feet in height, and bare ground and rock are as much in evidence as vegetation (Pl. III). On the flat valley floors, which are moister than the slopes, there is a slightly thicker, but lower and browner, growth of grasses (*Festuca rigescens* and *Calamagrostis curvula*). For a touch of green vegetation one must look for the great round heads of the moss-like yareta high up among the boulders, or for the occasional moist seeps coming down the mountainsides. Firm, moss-like mats of *Distichia muscoides* completely cover most of the moist places and seem to tumble out of the bowls and cirques like great green glaciers. The yareta is resinous and grows in stone-hard heads—quite inedible, and the *Distichia* grows in such tight mats that only with difficulty can a quarter-inch of green be cropped from it.

On the whole the region looks bleak and inhospitable, yet 200 viscachas thrived on the slope across from camp, and two dozen vicunas were seldom beyond calling distance of our tent. A line of mouse traps among the rocks and clumps of grass will catch as much as in a jungle, although not as much as at intermediate elevations.

A year at Caccachara is divided essentially into two seasons: a dry season (May to October) of sunny days and clear cold nights and a wet season (November to April) of warmer nights but cloudy days with frequent snow or hail storms. Fortunately, records have been published of temperatures, precipitation, and cloudiness at Santa Lucia, a location at 15,500 feet about seventy-five miles NNW of Caccachara (Bowman, 1916). These are given in Table 1, and although they are for the year 1913–14, they agree well with our own observations from August to December, 1946, at Caccachara. There is no reason to believe that the climate for the rest of the year would differ much between the two locations.

Bowman emphasizes the uniformity of the maximum daytime temperatures. The high from one day to the next seldom varies more than 3° or 4°F., and the midwinter highs are only 10°F. lower than those of midsummer. The temperature depends so much on insolation and radiation that when a cloud passes over the sun the temperature may drop as much as 20°F. in five minutes (Bowman). Travelers have spoken of "stifling heat" with the thermometer not over 70°F.

We stayed at Caccachara from August 6 until December 13, 1946, except for a week in mid-September, and from December 27 to January 2, 1939–40. These periods cover the last half of the dry season and the beginning of the wet. De-

spite the friendly climate when the sun is shining, the region is inhospitable at night or when cloudy and windy. There was precipitation every month of our stay, almost all of it in the form of snow or hail. The deepest snowfall was four inches. Characteristically the nights and mornings were clear; snowfall was usually in the afternoon. The fifteen-foot stream by our camp froze most nights with as much as one inch of ice, only to melt before eleven A.M. in the hot morning sun. During late November and December the stream froze less frequently, but since the temperature goes below freezing every month of the year there is

PLATE III

View across the Caccachara Valley. Many viscachas had their burrows among the rocks in the center of the photograph and fed on a large area of moss-like *Distichia* just out of the picture to the right. The tola shrubs, *Lepidophyllum* and *Senecio*, are one to two feet tall, and the pale crescents in the center are mats of the moss-like *Pycnophyllum aculeatum*. The bare area of dust and cinders in the foreground was spattered with viscacha, vicuna, and fox tracks. Altitude, 16,500 feet.

no "summer." The closest approach to summer from a temperature standpoint is the wet season—the season of most snow and hail. The mean temperature of the *warmest* month is about the same as that of Boston in April, and the mean for the year is the same as that of Boston in November, or Bismark, North Dakota, in April.

Description.—Viscachas look most of all like long-tailed gray rabbits. But they may not give this impression when you see your first ones—perhaps a dozen or two of them bounding recklessly up some rocky slope, tails streaming out behind. My first thought was monkeys, then kangaroos, then squirrels. Not until they stopped on top of the boulders to look at me, their long ears sil-

houetted against the sky, did I think of rabbits. Then neither the conspicuous and uniquely up-curled tail nor the sweeping mustache of coarse black vibrissae glistening in the sun could dispel completely the rabbit illusion. At close range the expression of the eyes is different, too, for one sees not the timid, frightened look of a cornered rabbit, but an aloof, confident expression.

The color of the adults is unusually variable for a wild population. Some of our specimens taken on a single hill vary from a creamy buff over the entire back of some to a dark grizzled gray in others (Pl. II). The belly is always paler than the back and is gray washed with buffy yellow. Buff or orange fur usually covers the ischial region, and there may be axillary and inguinal patches of white. Palms and soles are naked and black, but the backs of the hands and feet are

TABLE 1.—*Weather data from Santa Lucia (Taken from Bowman, 1916)*

DATE	DEGREES TEMPERATURE, F			PRECIPITATION, INCHES	NUMBER OF "RAINY" DAYS
	Mean	Max.	Min.		
Dry Season					
May	37	62	9	1.6	23
June	32	60	0	0.1	3
July	33	60	5	0.0	0
August	35	62	4	0.0	0
September	35	62	7	0.3	7
October	41	63	10	0.6	10
Wet Season					
November	46	63	24	4.3	21
December	47	70	22	6.4	15
January	47	70	26	3.3	14
February	47	63	30	3.0	17
March	47	68	28	4.4	20
April	43	...	...	0.9	13
Annual	41			24.9	143

furry, usually quite pale or even white. The ears are gray, or gray-brown, fringed with pale gray or white hairs. Coarse, pale hairs form a crest along the top of the tail and are sharply demarcated from the shorter, finer dark hairs along the bottom. The tip of the tail varies from black to red-brown.

The vibrissae and the hairs of the tail, ears, and inguinal white patches are uniformly colored to their bases, but the proximal two-thirds of all the other hairs is gray. The total color effect, no matter whether it is buffy, yellow, or brown, is determined by the color of the tips of the hairs. The darkest region is over the rump and there is frequently, but not always, a narrow, dark, mid-dorsal line running up to the shoulder region. Good colored pictures of related species may be found in Bennett (1835) and in Cabrera and Yepes (1940).

The fur on the head and body of newly born viscachas is a medium gray very

faintly washed with pale buff. Within a few weeks a yellowish cast appears, especially on the cheeks and in the inguinal region. A mottling of rich brown or rufous fur begins to appear when the viscacha reaches a weight of about one pound and some of this brown, especially a patch on top of the head, usually remains until the animal is more than two pounds in weight (about nine months old).

None of the viscacha pelts taken from July to January was prime, and they probably do not become prime at a season. The hide was always pale mottled with blue-gray, and tufts of fur could easily be plucked from all the pelts. Not all the fur plucks easily, however. In the case of one young-adult male (humeral age two, as defined later) probably nearing the end of the rufous stage, the mottled rufous patches on the back were easily plucked leaving bare patches of hide. Between these patches was new fur; short, gray with black tips, underlain by dark hide. Fur 15 to 25 mm. long covered the shaved patch on the back of a female that had been operated on and released for fifty-three days.

All the hairs are very fine and can be spun into yarn. In both viscachas and chinchillas the hairs spring from the hide in tufts to form exceedingly dense, soft, even fur. In the viscacha there are a dozen or so hairs to each tuft. The sparse guard hairs have slender shafts and stout tips. A set of coarse, curved bristles projecting above the claw of the inner toe on each hind foot probably serves to keep this fine fur from matting.

Female viscachas, unlike female chinchillas, are not perceptibly larger than males. The weights of ninety-one females and ninety-eight males from Caccachara, all of a humeral age of three or more, are compared below. No females were used that contained embryos larger than 10 mm. The linear measurements are based on 144 females and 144 males from Caccachara, all old enough to breed (over two pounds). It may be seen that the females were larger than the males in most respects, but in no case could the difference between the averages be shown to be statistically significant. Weight of males, 2.69 lbs. (2.1–3.3), females, 2.76 (2.3–3.4); total length, males, 611.1 mm. (561–665), females, 613.2 (549–675); tail length, males, 269.5 (239–320), females, 269.0 (231–304); hind foot, males, 92.4 (85–102), females, 92.7 (84–99); ear from notch, males, 63.9 (57–72), females, 64.2 (56–74).

Animals with bobbed tails were not used in the determinations of total length and tail length. Fourteen per cent of the adult males and 8 per cent of the adult females had bobbed tails; some were as short as 132 mm. I do not know whether frostbite, fighting, or some other cause is responsible.

Viscachas weigh about 0.4 pounds at birth, and one of this size was caught in a trap. Few this small, however, are seen running about the colonies at the time of year when we were collecting. The size distribution of the viscachas present at different times of year can be judged from Figures 1 and 2.

Numbers.—Viscachas are among the most abundant mammals in the highlands of southern Peru; they are as common as squirrels or rabbits in the eastern United States. Just as squirrels are restricted to woodland, so viscachas are restricted to "islands" of rocks. Although it is impossible to give accurate pop-

ulation figures, I have prepared a rough estimate of the population within three miles of our camp near the head of the Caccachara Valley. This camp site was chosen because it was surrounded by splendid viscacha habitats, therefore, the following figures must be considered an approach to maximum population density.

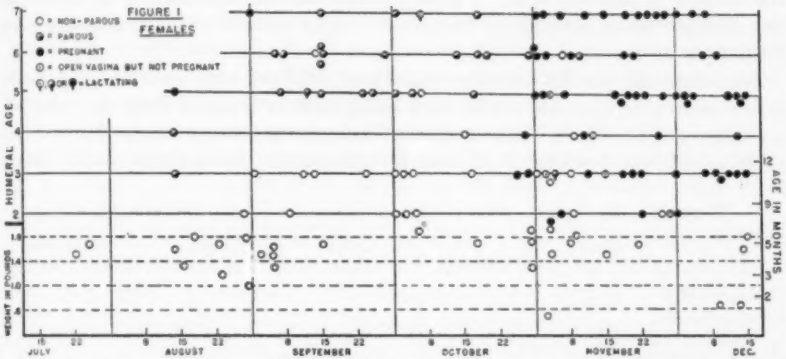

FIG. 1.—Age and sexual condition of wild female viscachas plotted with reference to the date of their capture. Age was based on weight until the viscachas reached two pounds, then on degree of ossification of the epiphyses of the humeri. Few humeri were saved until September. Females were judged to be parous if they had large, dark nipples and stout uterine horns.

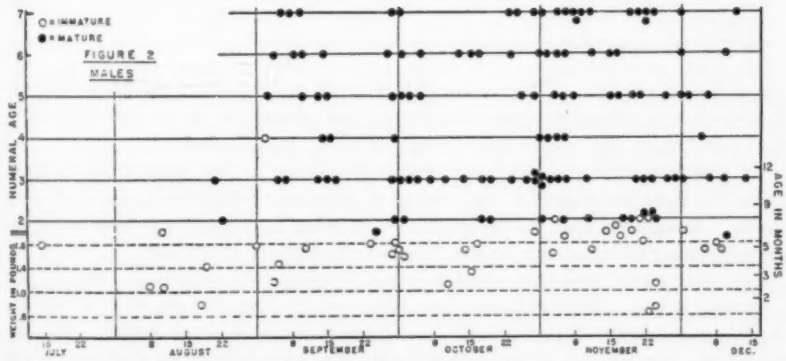

FIG. 2.—Age and sexual condition of wild male viscachas. Age was determined as in Figure 1. Specimens with sperm in the testes were considered mature.

The twenty-eight square miles around our camp supported thirty discrete colonies of viscachas, each colony contained from four to seventy-five individuals. We shot out many of the colonies completely, or to such an extent that the few survivors could be counted accurately, and, taking advantage of our experience and familiarity with colonies of known numbers, we estimated the number of

survivors in the remaining colonies. These thirty colonies contained about 780 viscachas: twenty-eight per square mile, or .04 per acre. This density may seem low to North American ecologists, but at Caccachara there are many square miles of desert, tola, and grass for every mile of cliffs and bouldered slopes. The number of viscachas is limited not so much by food, water, or predators, as by the number of suitable dens. I have no evidence that the number of viscachas has changed much throughout the years. They seemed to be as abundant in 1946 as in 1939.

Sex ratio.—Of the 498 viscachas examined, 48.7 per cent were males. Since it is conceivable that one sex is more easily shot or trapped than the other, I have also calculated, in Table 2, the sex ratio for isolated colonies that we entirely or almost exterminated, thereby including in the count almost every member of the population. There were 50.9 per cent males among 112 such animals. Comparison of this percentage with the overall percentage given above suggests that females are just a little more easily obtained than males.

TABLE 2.—*Sex ratio in colonies that were almost, or completely, exterminated*

COLONY	MALES	FEMALES	NOT COLLECTED
Live-trap Hill	7	7	0
Crystal Rocks	7	2	1
Riverside	3	6	0
First Fork	6	3	1
Steep Gulley	4	2	1
Lone Rock	2	2	0
Wind-scarred Rocks	2	4	1
Viscacha Manhattan	18	16	5
Shale Slide	8	13	4
Total	57	55	13

Of 389 viscachas shot, 48.8 per cent were males; 44 per cent of 62 trapped viscachas were males; and 51 per cent of 47 viscachas bought from Indians were males. It appears that the technique of trapping in front of the best burrows, mostly during the breeding season, favored the capture of females.

Of eighty-eight immature viscachas that weighed two pounds or less, 52 per cent were males. Since this does not differ greatly from the sex ratio of adults, the life expectancy of young males and females must be about equal. We obtained too few fetuses of sex-determinable size to establish an embryonic sex ratio.

Animal associates.—In the high valley of the Rio Caccachara the most conspicuous neighbors of the viscachas are the vicunas (*Vicugna vicugna mensalis*). Herds of these animals abound in the region and their tracks and droppings are seen everywhere except in the rocks where the viscachas live. Like the viscachas they are diurnal and thrive only in the high mountains above 12,000 feet, but they are animals of the grass and sand. I have seldom seen them among the

rocks and boulders, so they meet the viscacha only at the edge of the rock slides where *Lagidium* ventures as far as seventy-five yards out into the grass and sage to feed. The wary vicuna heeds the warning whistle of the viscacha and looks about for danger when he hears it, but viscachas do not appear to pay any attention to the alarm heehaw of the vicuna. Viscachas will take shelter, however, when a herd of vicunas files close past.

Huemuls (*Hippocamelus bisulcus*) and guanacos (*Lama guanicoe*) are also neighbors of the viscachas in some parts of southern Peru. The former are found only up to about 14,000 feet, however, and both these large artiodactyls are so rare that they have little effect on the viscachas.

The second most conspicuous neighbor is the tuco-tuco (*Ctenomys opimus*), a fossorial, gopher-like rodent whose untiring industry results in great bare patches on the grassy hillsides, but he too meets the viscacha only on the edges of its home rocks.

All of the close mammalian associates of the viscachas are mice: *Phyllotis darwinii*, a nocturnal inhabitant of the rock slides and cliffs; *Chroeomys pulcherrimus*, spectacularly bicolored coffee-and-white mouse that may be seen day or night; the short-tailed, vole-like *Punomys*, also active day and night; big nocturnal *Chinchillula sahamae*, most beautiful and silken-haired of Andean mice; and, closest associate of all, big-eared *Auliscomys boliviensis flavidior*. While watching viscachas in the morning sun, you may see the little head of one of these *Auliscomys*, topped by ridiculously long ears, pop out of a crevice. Then the whole mouse darts out to some sunny rock where he seems to melt in the relaxing rays of the sun, half closes his eyes, and sits contentedly among his sunbathing viscacha neighbors. Sometimes I have seen a second *Auliscomys* follow the first out into the sun, bask on a nearby rock, then cuddle up to the first when a cloud covered the sun. With eyes adjusted to viscachas it is always surprising and amusing when one of these little elves appears instead. When the viscachas flock down out of the rocks into the grass and sage in the afternoon, I have seen *Auliscomys* follow along to scratch and nibble among the "grownups," the late sun fairly glowing in its golden ear patches. This versatile mouse is equally at home in grassland, and many times I have seen its head and tense, expressive ears pop out of tuco holes.

Since viscachas eat almost every kind of plant that grows nearby, all these mice, although they are not abundant at the higher altitudes, must be considered food competitors. A line of ninety mouse traps at Caccachara (16,000 feet) occasionally caught nothing and seldom caught more than half a dozen mice in twenty-four hours. It is certain that here all the mice of all the species that share the "world" of the viscachas (rocky places and a strip seventy-five yards around them) eat much less than do the viscachas. At lower altitudes where the vegetation is richer, as at Pairumani (13,000 feet), a line of ninety traps would sometimes catch more than twenty-five mice in twenty-four hours.

Lizards (*Liolaemus multiformis multiformis*) live in the rocks among the viscachas, but there is little direct contact between birds and viscachas. Captive viscachas on two occasions showed great interest in week-old tinamous that were

running about outside the cages, and followed them up and down the length of the cage.

Predators and parasites.—The principal enemy of viscachas in the Caccachara region was the Andean fox, or wolf, *Dusicyon culpaeus andinus*. These foxes were abundant and they hunted day and night, much of the time in the middle of viscacha colonies. In several colonies we knew each hole that was occupied by viscachas; time and again after snow, fox tracks would lead unerringly from one hole to the next. Considering the abundance of viscachas, however, the foxes were surprisingly unsuccessful in catching them. I followed many fox trails in the snow, but never saw traces of a successful catch.

Allen Enders was fortunate enough to observe a fox stalking viscachas. The fox was moving along a ridge and stopped a short distance above a boulder under which was an occupied viscacha burrow. The fox could not see this burrow from on top of the ridge. Meanwhile, one of the owners of the burrow was sitting under a nearby boulder, saw the fox, and hopped away unseen without going towards its usual hole, which was dangerously close to the fox. After pausing for a time without seeing anything, the fox decided to chance a dash toward the burrow usually used by these viscachas. He caught nothing, saw nothing, and trotted off in sour grapes fashion. This incident, as well as the tracks in the snow, demonstrates that a fox knows the location of many of the viscacha dens in its territory. Foxes were seen on several occasions in viscacha colonies.

Viscachas use the same warning whistle for the approach of humans or foxes, and they allow the foxes to approach to about forty yards before seeking shelter. This is approximately the same as the "critical distance" for humans.

Feral or semi-feral dogs are probably the second most important predators, and Indians the third. In the absence of guns, the natives usually catch viscachas by using dogs that chase them into emergency holes which are not deep enough or secure enough. If they are within arm's reach these refugees are dragged out by the Indians; otherwise they are prodded out with sticks or iron pokers. A high proportion of immature viscachas is caught in this manner.

Although hawks are very abundant at Caccachara, I have never seen them dive at viscachas. Most of the hawks are too small to prey on adult viscachas, and they are usually allowed to pass over a colony unnoticed. Occasionally, however, a viscacha will give a short, shrill, hawk-warning whistle, to which the other viscachas and any *Auliscomys* respond by running toward their holes or to sheltered places. Pellets from a barn owl-sized owl living in the same cliff with viscachas contained no viscacha remains.

There were no grisons (*Grison*) at Caccachara, but they probably prey to some extent on viscachas when their ranges coincide. Pumas (*Felis concolor*) and skunks (*Conepatus rex*) were present but rare, and probably killed few viscachas. Wildcats were said to be present in the region, but we saw none. In general viscachas seem to have few successful enemies. This conclusion is borne out by the fact that they have a low rate of reproduction.

Most viscachas are host to roundworms and to very stout tapeworms which

may reach a length of 40 cm. Marietta Voge has kindly identified these as *Cittotaenia pectinata* (Goeze). I have never found more than three of these in any one animal. One viscacha less than three months old with a body only 26 cm. long was culturing two of these worms totalling 70 cm. These tapeworms were present in animals that had been captive seven weeks.

Most viscachas also have some ectoparasites, but few are heavily parasitized. Fleas were frequently found, and Dr. F. L. Werneck has been kind enough to identify the following lice: *Gyropus lagotis* Gervais, and *Philandesia chinchillae* (Werneck). The viscachas sprawl and roll occasionally in dust baths, and "combs" on the hind feet may help to dislodge troublesome boarders.

General habits.—Unlike chinchillas and plains viscachas, mountain viscachas are diurnal. They get up with the sun, or sometimes a bit before it, and go to some favorite perch on top of a boulder or cliff where they dress their fur and sit on their haunches soaking up the welcome heat of the early morning with eyes half closed in contentment. In the evening they usually feed until after sunset and return to their burrows before dark. I have frequently seen viscachas feeding or perched on a rock after dusk, and once or twice I have seen a few on the rocks near their burrows an hour or two after dark, but visits to populous colonies both on dark nights and in the crisp clear moonlight of the high Andes usually revealed no viscachas. Those few seen at night seemed to be able to bound sure-footedly, but with less speed and confidence than during the day. Their eyes shine yellow-orange in the beam of a flashlight.

While sunbathing, viscachas may sit relaxed on their haunches like slightly hunch-backed squirrels, or they may lie on their stomachs rabbit-fashion, or even occasionally stretched out on their sides. One often sat Buddha-like on his ischia with the soles of his back feet approximated and his paws dangling on his fat belly.

Viscachas are gregarious. Never have I encountered one living alone. Occasionally only two will occupy some pile of rocks, perhaps not even living in the same hole, but more often a dozen, or two dozen, or, if the location is suitable and extensive, seventy or eighty will live harmoniously in a colony. Usually there are two to five in each burrow, probably a "family" as described later. The members of a family group like to cuddle up to each other as they bask in the sun, and there is little hostility between adjacent family groups. Little attempt is made to preserve a "territory." Indeed, the entrances to the burrows or dens of neighboring families may be only a few feet apart.

I have never seen viscachas really fight. Occasionally they will stand up to each other and spar with their front feet or noses, but never do they really come to blows. Even indiscriminate mixing of unacquainted viscachas in small cages did not induce fighting, although occasionally one would pick on another to the extent of pulling out tufts of hair—apparently without objection from the "underdog." Even during the breeding season, bluff, a lunge, a squeak or two, and a short chase are the extent of belligerence. I have seldom been bitten by captive viscachas, occasionally "pinched." Twice I have seen a viscacha direct a squirt of urine at another. Both times this defensive weapon drove off the aggressor,

although the aim was not perfect. Some natives in Panama believe that the spotted paca (*Cuniculus paca*), also a hystricoid, will do the same thing when cornered, and that the urine will blind humans.

Seldom does a hunter surprise a viscacha. But their wariness is a group characteristic as well as an individual one. A hunter is usually approaching not a lone viscacha, but a colony; a dozen pairs of eyes are on the lookout and there is seldom enough vegetation to conceal the stalker. They can easily see—and run from—a man 200 yards away. Hunting them is made simple, however, by the fact that once amidst familiar rocks their confidence returns, and they will then sit in plain view while the hunter approaches to perhaps fifty yards, sometimes even thirty yards. Some colonies allow one to approach closer than others, depending on how much they have been hunted, but it also seems that densely populated colonies are tamer. Perhaps each viscacha draws a bit of confidence from the ones around him.

Vision is certainly the sense upon which they rely most. Their hearing is as good as man's. They readily react to a thin, high-pitched warning whistle that sounds faint to the human ear. Wolffsohn (1925) mentions a saying in Chile; "deaf as a viscacha," but states that although it is easy for a man to approach to about fifty yards (especially from above), their sense of hearing is very well developed. Mann (1945) believes that they do not hear deep sounds such as thunder or human voices but that they are sensitive to higher frequencies such as the rustle of dry grass. I know nothing of their sense of smell.

When a colony has been shot up once or twice, the surviving members become more shy. They will disappear as soon as they see a man, instead of sitting up on a rock to watch him.

Bennett (in Allen and Garman, 1875) reported that viscachas are "not very tenacious of life, being as easily killed as a rabbit." Nevertheless, we found that one must either hit them in the head or with a powerful bullet to prevent them from crawling the few feet that usually separates them from a retreat inaccessible to the hunter. On more than one occasion when an expanding bullet had completely removed the stomach, spleen, pancreas, and all the intestines, the animal ran as much as twenty-five yards at high speed into its burrow.

Their most characteristic method of locomotion is by reckless, carefree bounds from rock to rock, or ledge to ledge. Among cliffs and boulder slides they are at home and untouchable; on open ground I believe that a man could run one down—a dog can easily do so. When not hurrying they move over level ground by slightly slurred hops about one to one and one-half feet long, or if trying to be inconspicuous they may even walk or slink instead of hopping, but when they hurry they stretch out these hops to six feet or more and leave the ditto-dot-dot prints so familiar to acquaintances of our cottontail rabbit. It will be seen in Plate II that the front feet do not fall as nearly in line (tandem) as do those of a rabbit. At slow speed the front feet fall abreast like those of gray squirrels. The tail does not drag, even in an inch or two of snow. Viscachas can swim when it is necessary.

Despite the fact that many viscachas live under boulders, in burrows that

must have required some digging, they are poor diggers. Their claws are very short, and I have never seen one undertake any excavating more ambitious than shallow scratching for edible roots and stems. Their burrows, if not crevices in solid rock, are under boulders in gravel or loose soil that makes for easy digging, and probably many generations of viscachas have done a stint to make these burrows suitable for permanent occupancy. No other animals in the region dig burrows suitable for adoption by viscachas. Natural rock crevices and crannies are just as desirable as are burrows if the entrance is too narrow to admit a fox and the den deep enough to be cozy.

Viscachas reveal their presence by droppings more frequently than by tracks. The scats are about 15 mm. long, have the same appearance as those of a Norway rat, and are deposited in "nests" of a dozen or so at a time. They may be found anywhere in a colony—on top of lookout rocks or in sheltered crannies. There is a tendency to deposit them more frequently in certain places, some of which have been used so often and for so long that the ground is covered for several square feet; indeed, I have visited some populous colonies at the end of the dry season when the whole hillside seemed to be a mixed heap of equal parts of boulders, cinders, and scats. The pellets seemed to be slightly larger in December than in the dry months.

The presence of viscachas is also indicated by occasional tufts of fur lodged in plants or among rocks, by tola bushes with the bark stripped off, and by the presence of beaten pathways between two favorite rocky places or between a popular feeding place and the home rocks.

Viscachas are easily shot or trapped. One can stalk them, using a rifle, or one can walk openly with a shotgun through a populous colony and be rewarded with many shots at less than fifty yards. We preferred to watch a colony for a time from a distance of seventy-five to one hundred yards, then pick off with a rifle the desired individuals. We found that the most satisfactory method of trapping was to chase or watch individuals until they entered a burrow, then to set cage traps over every exit so that the animal (or animals) could not leave the burrow without entering a trap. Although this sounds easy, it was sometimes very difficult to make them enter burrows. I have "herded" viscachas back and forth through a colony for an hour without seeing a single one go into a hole. Some individuals seemed to delight in staying twenty or thirty yards ahead of me until we approached the edge of the colony, then these elusive individuals would slip past me and the drive would be repeated. The viscachas that behaved in this way were usually ones that lived in large colonies among tumbles of boulders where safe refuges were almost always close at hand. Viscachas living in cliffs or in isolated rock piles were more apt to disappear at once into their dens.

Voice.—The principal sound made by both male and female viscachas is a series of very high-pitched, mournful, warning whistles, each of which might be described as a "wheee." The whistle is usually repeated three or four times at intervals of a little more than a second. Each "wheee" lasts about one second, has a slight change in pitch at the very beginning, and just the faintest quaver

which makes it sound more plaintive than the shrill cry of a hawk. To viscachas among the rocks it means "look out," or "heads up." They will stop whatever they are doing, some will bound up onto high rocks for a better view, and all will sit still and alert for many minutes. Viscachas feeding out in the open usually bound to the protection of the home rocks as soon as they hear the whistle. I have seen an *Auliscomys* scoot for shelter as soon as this warning whistle was given, despite the fact that the viscachas next to which he was feeding merely froze. Some captive viscachas whistle forlorniy, especially if their cagemate has been picking on them or will not let them into the nestbox. When they make the sound one can see no accompanying movement of the mouth or throat, only a slight "tension" of the ears and a slight swelling of the body at the time of the inhalation before each whistle. Occasionally in the wild the warning whistle is repeated more rapidly, whereupon it sounds urgent rather than plaintive. Young viscachas are apt to whistle after they have been chased into a burrow.

A shorter, sharper whistle is sometimes given when a hawk flies over a colony. Many of the viscachas react by running under overhanging rocks or other sheltered places, but I have seen none go into their holes on such occasions. At other times I have seen hawks pass overhead quite unnoticed.

Aside from the long warning whistle and the short hawk whistle, viscachas squeal when hurt or frightened, occasionally whimper softly as they hop along (especially during the breeding season), growl at each other, and when squabbling among themselves make a squeaky-leather sound much like that of meadow mice (*Microtus pennsylvanicus*), but louder. They almost always cry when held by the back feet, but hang quietly when held by the tail or when in a sack. Sometimes they thump their hind feet as they bound away from an intruder. This probably acts as a warning signal like the tail-slapping of beavers. Viscachas frequently flick their tails in squirrel fashion when they are nervous or irritated. While driving away another viscacha some individuals utter a growl-chuckle and flick their tails so angrily that the dust flies. I have never heard them "chatter to each other" as described by Bowman (1924).

Food.—Instead of traveling long distances to find appetizing species of plants, viscachas are content with almost any of the species found among the protective home rocks or within seventy-five yards of them. No one plant is essential; viscachas in some colonies subsist primarily on plants that are not found near other colonies. The only food plants common to all the colonies are lichens, but these, although eaten frequently, do not form a major part of the diet. Young viscachas seem to eat them more frequently than do adults.

Wild viscachas usually leave the rocks for their feeding grounds after they have been well warmed by the morning sun. They spend a few hours feeding, hopping haltingly from sage to spiny grass to thorn bush, chewing all with great thoroughness into an inseparable yellow-green pulp. After this morning feeding they return to the rocks where they loaf and perhaps scrape a few lichens or nibble on the tola or other plants that are available among the rocks. They return to the feeding grounds again in the afternoon and may be watched as they

go intently from plant to plant nibbling rapidly, almost frantically, as if at any moment a fox or other interruption would send them bounding home hungry for the night. I have never seen them carry food into their holes or store it.

A full viscacha stomach contains more than forty grams of vegetable pulp; it is probable that they fill their stomachs twice a day. So thoroughly do they chew and so ineptly do they handle some foods that eating this much can be quite time consuming. They prefer to eat each blade of grass singly—and longitudinally—chewing it in millimeter by millimeter without much help from their paws. The finding of food seems to be no problem, for almost any plant, no matter how thorny or pungent, is eaten. I have never seen a colony that had seriously depleted its food supply. Predators would reduce a colony that had stripped the plants close to home since feeding time away from the home rocks is the most vulnerable time.

Despite the variety of their diet in the wild, captive viscachas refused most of the unfamiliar foods offered. They ate rolled oats and barley sparingly, but refused wheat, corn, corn meal, soybeans, rice, quinoa, raisins, and pecans. They ate the local wild foods eagerly, especially the green parts of all the grasses. With the exception of the three listed as not eaten in Table 3, no plant was too rank or too spiny for them. Although they were supplied with all the oats or barley they would eat and enormous quantities of greens, all the captives lost weight. Many starved although they were eating a great deal. Viscachas have survived on mixed diets in zoos, as mentioned later. Giusti and Hug (1922) stated that their captive plains viscachas did well on oats and water—a diet that killed guinea pigs and rabbits.

The captive viscachas were remarkably slow and inefficient eaters. Not only did they chew grass one blade at a time, but they ate grains of barley one by one, taking an average of twelve seconds to consume each one. At this rate it would take three and one-half hours of continuous chewing to eat one day's requirement (about 130 calories) of this comparatively calorific cereal. It is no wonder that wild viscachas go about their evening feeding on meager vegetation with intense, almost desperate seriousness.

Reproduction.—Reproduction of viscachas will be only outlined here, as a detailed report will be published elsewhere.

Males come into breeding condition when they reach a weight of about two pounds (approximately seven months) and remain fertile for the rest of their lives (Fig. 2). All testes 18 mm. and longer contained sperm, and all smaller than this were aspermatic. Growth of the testes between 14 mm. and 22 mm. is very rapid, since only three of 319 males examined had testes within this size range. Females weighing two pounds are capable of breeding immediately if they reach this weight in October, November, or December, but if they reach two pounds in July, August, or September, they usually do not breed until later (Fig. 1).

Grown males were in breeding condition during our entire stay (July to January), and since young viscachas and pregnant females were not uncommon in July, it appears that the males are capable of breeding the year round. Almost

no females are pregnant during August, September, and early October. Copulations began at Caccachara about the middle of October. The vaginal plug that forms from the semen is a white, finger-like cast about 17 mm. in diameter and 40 mm. long, moist and firm while still in the vagina; hard, tough, dry, and somewhat shriveled after it has been expelled. These plugs are probably retained in the vagina for less than a day.

The beginning of the breeding season can be detected in the following ways: behavior (see below), the capture of females with open vaginas or containing

TABLE 3.—*Food of viscachas*

NAME	COMMON NAME	PARTS EATEN
Plants eaten frequently or in large amounts		
Lepidophyllum	Tola	Leaves, bark, blossoms
Distichia muscoides	?	Leaves
Senecio adenophylloides	Tola	Bark, blossoms
Senecio antennaria	Creeping senecio	Leaves, stems, blossoms
Festuca orthophylla	Spiny grass	Growing or dry stems
Senecio spinosus	Thorn bush	Leaves, stems, blossoms
	Lichens	All
Plants eaten sparingly		
Opuntia sp.	Cactus	Fruit
Calamagrostis nitidula	Bunch grass	Stems, seeds
Pycnophyllum aculeatum	Mat moss	Buds
Common plants not eaten		
Azorella yarita	Yareta	
Werneria near *lorentziana*	Urinaceous ground pine	
Astragalus arequipensis?	Blue-flowered legume	

(Innumerable tiny green plants which could not be identified because they were cropped so closely and chewed so thoroughly also contributed to the diet. The following genera were probably represented: *Calandrinia*, *Gentiana*, and *Werneria*.)

vaginal plugs, the finding of expelled vaginal plugs about the colonies, and capture of pregnant individuals.

In the female the vagina is closed except for a few days at the time of breeding and parturition. Ovulation occurs at about the time of copulation. Only one ovum is released and this almost always from the right ovary. It is fertilized promptly and becomes implanted in the right uterine horn so that a perceptible swelling is visible in the uterus within two weeks of copulation. If the right ovary is removed before the breeding season, the left ovary ovulates and the embryo grows in the left uterine horn.

Growth of the single embryo is exceedingly slow. Five weeks after ovulation the embryo itself is still less than 3 mm. long, although the swelling in the uterus may be 16 mm. in diameter. At parturition, which I estimate to be three

months following copulation, the young viscacha is fully furred, has open eyes, weighs about 0.4 pound, and can probably eat plant food immediately (Pl. II).

At times there is a post-parturitional heat. Indeed, this may be usual following births in the Southern Hemisphere summer months. If such is the case, each grown female may produce two or even three young each year. In view of the short life span of viscachas one would expect each female to produce at least two young each year.

Lactation.—The single pair of mammary glands is situated on the sides of the thorax. In immature females, and in males, each nipple is a tiny pale papilla protruding from a bare area of skin about 20 mm. in diameter, but the surrounding hair is so thick and long that this bare patch does not show unless the fur is parted. The nipple increases slightly in size at the first oestrus and becomes quite large and dark after the first pregnancy. In non-lactating, parous females the nipple remains as long as 10 mm., but it is always narrow, usually about 2 mm. wide. In these individuals the nipple is usually dark gray, and this feature, coupled with its large size, is a reliable indicator of a parous female.

Mammary tissue is in evidence only during lactation. At the height of lactation there is an oval of mammary tissue as much as 10 cm. long underlying each nipple, and milk can be expressed readily.

The females nurse for at least a month after parturition. One wild female was observed nursing on eight occasions from August 25 to September 28. How much longer lactation continues I cannot say. Some females were nursing young that weighed as much as 1.5 pounds, which suggests a nursing period of more than four months, but it cannot be stated definitely that the mothers were not freshened by the birth of another young one. One thing seems certain—the young require very little if any milk. Captive viscachas only a few days old drank sweetened milk when it was offered, but they spent most of their time foraging for lichens, grass, or almost any other plant. Every wild viscacha that was shot had vegetable matter in its stomach, and not one, no matter how young, had more than a trace of milk. Several times I have seen a young viscacha nurse for about five minutes, then hop a few feet away and nibble on lichens.

While nursing, the young viscacha sits upright alongside its mother, who in turn sits on her haunches. If an observer were not familiar with the remarkably lateral position of the nipples he would not suspect that the young viscacha was nursing. More remarkable than this, however, is the fact that twice I have seen a large female simultaneously nursing two young viscachas of different sizes, both estimated to be between one and two pounds. Since only one young is born at a time, these must either have been two successive offspring of hers, or one of hers and one belonging to a neighbor. In either event, it is a situation that rarely if ever occurs among other animals. The production of such precocious young seems to have freed the nursing rite from some of its usual social restrictions.

Breeding behavior.—The approach of the breeding season was first suspected

on October 2, four weeks before the first females with visible uterine swellings were collected and sixteen days before the first oestrous female (judging by large follicles and an open vagina). Whereas the viscacha colonies had been almost models of domestic harmony before this time, on October 2 there was squabbling, chasing, and considerable squeaking. At this time, and during the next few weeks, the females became increasingly belligerent and the males increasingly cautious in approaching them. We watched one female that was so touchy that she drove off not only all adult viscachas interested in her or in the food near her, but she even lunged at and drove off an immature male nibbling innocently nearby. In several instances a female viscacha permitted a male to approach her from the front and rubbed noses with him, but when the cautious male attempted to work his way around behind her she would make a slight movement in his direction and he would leap away. This performance was observed frequently, and led me to the conclusion that *proestrus* was the stage in which the female allows the male to approach *in front* of her. One viscacha behaving in this manner was found to be a 2.5-pound, nulliparous female with closed vagina and slender uteri, but with a medium-sized follicle (0.8 mm. in diameter) in her right ovary.

Another female continued during proestrus to care for two younger viscachas habitually associated with her. One of these young viscachas was an immature male and the other, whose sex was undetermined, was a medium-sized animal with a cranial patch of rufescent fur—indicating young adulthood. The first female presumably was the mother of these young viscachas and they were often observed together nuzzling, rubbing, and washing each other's fur.

With the advent of the breeding season the males became more promiscuous than earlier in the year; one male was observed attending several females, and on numerous occasions several males courted a single female. Occasionally, however, a male assumed a possessive attitude towards a female and drove other males away from her. The activities of the males at this time frequently were accompanied by a soft, muffled, slightly annoyed squeak, which they sometimes made in rhythm with their movements.

The general excitability of the males during the breeding season may be indicated by the fact that one viscacha manifested erotic behavior towards a human. This viscacha hopped up to within four feet of the observer, watching the latter all the time, then hopped away to about fifteen feet where he stood on his hind feet, raised his tail, and gave several pelvic thrusts. The penis protruded about three-quarters of an inch in a down and slightly backward direction. Then he bent over, nuzzled the genital region, and hopped off to about twenty yards to feed.

On October 23, we first saw more definite signs of breeding. One male mounted a female twice, but did not pursue her when she hopped slowly one or two hops away. The female in this case made no attempt to drive him off. At another colony, the male mounted and made eight or ten thrusts. The female did not present, however, and there probably was no intromission. The male licked or nuzzled his genitals afterwards. A third male was seen to mount

on November 2, but again there was no thrusting by the male or back-arching by the female.

Occasionally viscachas sat in a copulatory position, but apparently without reproductive intent. Two different pairs of viscachas were disposed to sit quietly in this fashion for as long as an hour at a time. Between August 25 and October 23, one pair was seen six times sitting in this position at the same spot on a rock shelf, and on several occasions one ran up and voluntarily assumed the "under" position. This behavior probably had no direct sexual significance although it must have provided tactile or proprioceptive satisfaction.

One affectionate couple, on October 30, was seen licking each other's fur while they stood on their hind legs, the female with one paw on either side of the male's neck. This female had an open vagina, stout uteri, a young corpus luteum in the right ovary, and a one-celled ovum in the middle third of her right oviduct. The male had testes 31 mm. long and weighed 2.8 pounds. The first female with a visible swelling in the uterus was collected on October 29. By November 14, the breeding season had begun to wane, and visits to the viscacha colonies revealed little of the chasing and "proestrous" behavior characteristic of all the "rookeries" a few weeks before. That the breeding season was not over, however, is evidenced by the vaginal plugs that were found in females on November 15, 18, and December 1. All adult females were pregnant in December.

None of the captive animals copulated. One female showed considerable interest in a male for about one day, following him about and attempting to mount him, and several males spent hours following one of the females in their cage, sniffling almost continually at her genitals. A few males attempted to mount by grasping the fur on the back of a female's neck in their teeth, but the females never co-operated.

The fact that we never witnessed a copulation, despite spending long hours watching colonies during the breeding season, leads me to suspect that copulation is brief and infrequent. After one mating the vaginal plug probably prevents re-mating until several hours later. So few vaginal plugs were found that it seems possible that receptivity has ended by the time the plug from the first copulation has been expelled.

Determination of age.—The most satisfactory method of determining the relative age of viscachas combined the use of body weight and epiphyseal ossification. After boiling the humerus and cleaning off the meat, the degree of closure of the epiphysis between the head and shaft was determined by comparison with a graded series of four reference humeri (Fig. 3). Using these four stages, and one stage between each of them, gave a series of seven classifications correlated closely with age. All viscachas that weighed two pounds or less fell into humerus-group 1. Since weight is a reliable indicator of age in young animals, it was easy to subdivide group 1 further on a weight basis. This made it possible to grade each viscacha from birth until closure of the humeral epiphyses—a process that is completed relatively late in life.

Color of the fur, condition of the reproductive organs, weight of the baculum

of males, and length of the rostrum were additional features of limited use in determining age, but none of these was as satisfactory as epiphyseal closure. The skulls of almost all the females were saved, and although the length of the rostrum, as measured by the length of the nasal bones or by the length of the diastema between the front incisors and the first cheekteeth, was the most satisfactory age indicator, it still gave only a rough estimate of age in the older groups. The cranial sutures do not close appreciably with age, and the molars grow throughout life without apparent wear.

In the absence of long-term banding experiments, transposition of humeral and weight ages into absolute age is difficult and admittedly crude. I have attempted to do this in the following section, making use of the meager data

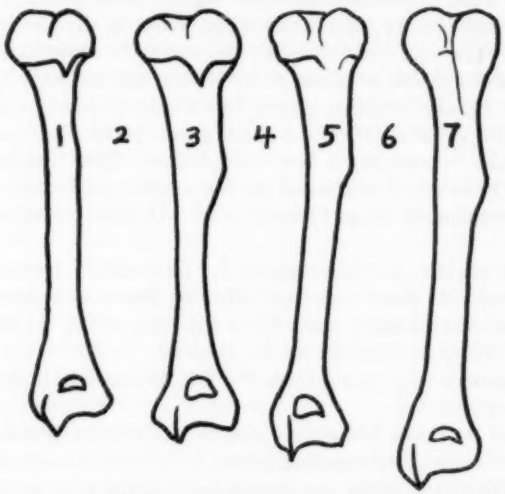

FIG. 3.—Humeri showing various stages of epiphyseal ossification

available on growth of the young, and of indirect data based on the composition of known family groups.

Rate of growth after birth.—Viscachas did so poorly in captivity that captives could not be used for growth measurements. Observations on banded, released viscachas are summarized in Table 4. The most obvious conclusion that can be drawn from Table 4 is that viscachas do not grow! Closer examination reveals that a few of the young viscachas increased in linear dimensions, but not one gained weight. This can only be explained on the basis of weather. All the recaptures were between December 7 and 12 after three weeks of miserable, wet, snowy weather. Viscachas must spend several hours each day feeding, and during the first week of December they could not do this regularly without getting wet. Consequently they lost weight, but none appeared to be emaciated.

Despite the evidence given in Table 4, I am convinced that viscachas *do* grow.

The only method left by which I can estimate the rate of growth is an indirect one based on the composition of family groups. For example, a female that had become pregnant at a post-parturitional heat was nursing a 0.7-pound baby. Since her second embryo was about fifty days old, I have assumed that a 0.7-pound young is about fifty days old. I admit that such indirect methods of estimating age are risky, but they are a last resort. Many such scraps of evidence have been pieced together in order to construct, along the right-hand margins of Figures 1 and 2, a scale for transposing weights and humeral age into absolute age.

TABLE 4.—*Growth of released specimens. Measurements of total length, tail, hind foot, and ear are in millimeters*

NUMBER	DATE CAUGHT	DATE RELEASED	DATE RECAPTURED	LAPSE, DAYS
588 ♀	Oct. 14, 2.2 lbs. Rt. ovary removed on Oct. 15. 561 x 254 x 88 x 66 mm.	Oct. 16, at home den.	Dec. 7, 2.1 lbs. 566 x 261 x 88 x 67 mm.	54
668 ♀	Nov. 1, 1.6 lbs. 523 x 226 x 87 x 59 mm.	Nov. 2, at different den.	Dec. 11, 1.6 lbs. 541 x 241 x 87 x 60 mm.	40
591 ♀	Oct. 15, 2.5 lbs. Rt. ovary removed.	Oct. 18, at home den.	Dec. 8, 2.4 lbs.	54
762 ♀	Nov. 16, 2.4 lbs. Laparotomy, nothing removed.	Nov. 17, at home den.	Dec. 12, 2.2 lbs.	26
779 ♀	Nov. 19, 2.6 lbs. Laparotomy, pregnant, nothing removed.	Nov. 19, at home den.	Dec. 12, 2.6 lbs., still pregnant.	23
780 ♀	Nov. 19, 2.6 lbs. Laparotomy, pregnant, nothing removed.	Nov. 19, at home den.	Dec. 12, 2.5 lbs., still pregnant.	23
842 ♀	Dec. 1, 2.4 lbs. Pregnant, removed right ovary.	Dec. 3, at different den.	Dec. 13, 2.0 lbs., not pregnant.	12
614 ♂	Oct. 19, 2.7 lbs.	Oct. 20, at home den.	Dec. 7, 2.6 lbs.	49
840 ♂	Dec. 1, 2.0 lbs. Laparotomy.	Dec. 2, at different den.	Dec. 12, 1.7 lbs.	11

I have been unable to assign absolute ages to the older animals. However, judging from the number of animals in each age group in Figures 1 and 2, it becomes obvious that viscachas do not live very long. There is no accumulation of animals in the older age groups; indeed, the entire population over one year of age is only about as numerous as the population under one year. It may be concluded from this fact that few viscachas live more than three years. As is the case with so many other small mammals, little can be said regarding the fate of old individuals.

Social organization.—It has been mentioned above that viscachas are gregarious to such an extent that sometimes as many as seventy-five live in one colony. These colonies are composed of smaller groups consisting usually of two to five individuals. The smaller groups appear to be families, but their

composition is not the same throughout the year. In July, August, and September most of the viscachas in a colony are paired or belong to larger family groups. Each pair consists of a sexually mature male and a parous or pregnant female. The larger family groups contain a mature male and female (presumably the parents) and one, two, or occasionally three young of different ages. The oldest male offspring may be sexually mature yet still living with the family.

Variations from the usual family grouping described above occur frequently, of course. One group living under a boulder isolated by several hundred yards from any other dens was composed of a parous female (humeral age 6), an immature female (1.3 pounds), and two old males (humeral ages 6 and 7).

It is an anachronism of viscacha reproduction that one is less apt to encounter pairs of viscachas during the breeding season than at other times. Presumably the females become "touchy" as oestrus approaches, will no longer tolerate the presence of adult males, and drive them from home. The immature offspring, being at this time interested primarily in food, are permitted to remain. There must be some shifting of dens by the females, however, because three or four proestrous or estrous females (and a few young of either sex) sometimes live in the same burrow during the breeding season.

Two or three evicted males sometimes share a den, while others during this period seem to lead a free lance existence about the colony. It is not improbable that these homeless males are unusually susceptible to predation.

After they have become pregnant, females will again tolerate males, and a harmonious family life is resumed. I do not know whether the same pairs sort out after the shuffle caused by the breeding season.

Viscachas live at such close quarters with each other that there can be little establishment and defense of individual or family territories. The entrances of two dens may be only a few feet apart. Nevertheless, all places in a colony are not communal. A certain viscacha, a certain pair, or a certain family will be seen week after week at the same spot on a ledge or on the same boulder. One family of four habitually sunned on the same rock; sometimes all would be huddled together, and at other times they would be scattered about the rock, hopping onto it and off again at frequent intervals. Despite the fact that a dozen other viscachas could usually be seen sunning, feeding, and playing all around it, I never saw one of these neighbors venture onto the rock. They passed within a few feet of it many times, but clearly avoided it, although the family in possession never made any attempt to chase them away.

Individual viscachas occupy the same burrow for long periods. Some individuals were seen almost daily at the same den for five months. Moreover, viscachas that we trapped at a certain hole usually continued to live there if they were released there. Of fifteen trapped viscachas that were marked and liberated at their home dens, we recovered eight. One other was known to be present and a few of the others were suspected to be present, but avoided us in the few days we allowed for collecting them. All those retaken were shot near their original den. The longest period of liberation was two months.

Viscachas liberated at different dens than their own did not fare so well—or emigrated. Thirteen marked viscachas were released at a location from which all the original viscachas (nine of them) had been removed. Only one of the released ones was recovered and it was probably the only one remaining. Six others were released at a colony that had supported fourteen viscachas before, but two of the six had vanished within ten days. In each case the marked viscachas were liberated into burrows that had been used by the original wild colony.

Captives.—The captives were kept in cages of wire of one-inch mesh. The cages were four feet long, one foot wide, and about one and one-half feet high. A small stone igloo or a den made from a five-gallon kerosene can was provided at one end as shelter for the one to three viscachas kept in each pen. The viscachas quickly became accustomed to cage life, made few attempts to escape, and ate eagerly. However, they steadily lost weight, as mentioned in the section on food, and many died when they had wasted to about 1.8 pounds.

Mr. Lee S. Crandall of the New York Zoological Society has kindly furnished me with the following information concerning the mountain viscachas that have been exhibited in large outdoor pens at the Bronx Zoo. They live outdoors in winter and summer and have lived two or three years on a diet containing such things as carrots, apples, bananas, celery, lettuce, corn, rolled oats, and a commercial cereal mixture. One female was killed by a cage mate in March, 1947, and another gave birth to one young in May, 1947, but the baby did not survive.

The specimen described by Bennett (1835) survived a voyage to England and somewhat less than a year of captivity in the menagerie of the Zoological Society. Feuillée (1725) saw domesticated viscachas in houses in Lima. The related chinchillas and plains viscachas have survived nearly seven years in captivity (Flower, 1931).

Adaptations to altitude and climate.—Little is known of altitudinal adaptations of viscachas. It is obvious that low oxygen tension does not limit them in their every-day activities in and near rock piles, but their stamina is probably not great, for a newly captured viscacha that escaped as it was being transferred into a cage tired rapidly and took shelter under a rock after being pursued only 200 or 300 yards by the author and two Indians.

Hall, Dill, and Barron (1936) reported that the blood of viscachas has a greater affinity for oxygen than does that of rabbits, and that the arterial saturation was higher than that of any man in their expedition at high altitudes. However, the oxygen capacity, the arterial saturation, and the alkaline reserve were about the same as those of rabbits at sea level.

The luxuriously soft, fluffy fur is probably admirably suited to protect viscachas against the cold temperatures at high altitudes, and their system of molting in small scattered patches fits them for life in a region where there is no summer in which to accomplish a complete molt. The scarcity of guard hairs, however, allows the fur to wet easily, and a wet viscacha does not survive long in this climate. Both captive and wild viscachas retreated to shelter when it snowed or hailed. Occasionally wild ones could be seen sitting up on a crag

in the full sweep of a wind-driven dry snow, but as often as not these individuals were interested in watching the intruders. Were it not for this entertainment they would be down under the boulders in their cool but dry burrows. Even a strong cold wind without snow drives many to shelter because it parts the fur down to bare skin.

When several inches of snow cover the ground the viscachas do not venture out to feed. One morning, after four inches of snow had fallen overnight, many viscachas hopped a few yards out onto rocky shelves or lookout points, urinated or defecated, or both, then returned to their burrows. Only one of a colony of twenty-seven had ventured down from the rocks to feed on a clump of grass (*Festuca*).

The fact that released viscachas lost weight during the snowy days late in November and early in December suggests that they are to a considerable extent at the mercy of the weather. From November 15 to December 9, there was snow, rain, or drizzle every day; sometimes the precipitation lasted almost all day. Frequently a few inches of snow covered the ground at daybreak and melted before noon, but more precipitation usually fell in the afternoon. Since viscachas are diurnal this left only a few favorable hours for feeding. It is not unlikely that some viscachas would have starved had this miserable weather continued for another two weeks—as indeed it may have, for December is the wettest month of the year.

Viscachas do not store food to tide them over periods of miserable weather. It is also surprising that the principal crop of offspring is born in the middle of the wet season. Perhaps viscachas have not been able to change a predisposition toward spring breeding to adapt to local weather conditions.

On "stifling hot" days, captive viscachas moved into the shade of their nests, and many wild viscachas in colonies sheltered from the wind stayed out of sight.

Economic importance.—In Peru, in times past, viscacha hair was mixed with alpaca, vicuna, or other fibers and spun into yarn for making exceedingly fine cloth (Cieca, 1533). Feuillée (1725) stated that the reason for using viscacha hairs was to vary the color of the finest yarns. Wolffsohn (1925) remarks that the Araucanians in Chile also spun wool from viscacha hair, but that this skill has now been almost forgotten. At present some viscacha fur is being used for making felt hats in Bolivia and Peru, and a few pelts are tanned for making robes and trim, but the fur probably does not wear well and, as mentioned before, many patches of the fur are easily plucked. In fact, Ulloa (1772) went so far as to say that as soon as viscachas die their hair falls out.

Their most important use at present is for food, but even for this purpose they are not widely hunted. The Indians catch them with the help of dogs that are able to chase the viscachas into "emergency" holes as described before. Some Peruvians held the belief that eating viscacha meat would make your hair turn gray, but we ate male and female viscachas almost daily for four months, did not tire of them, and noticed no acceleration of graying. The back and hindquarters are somewhat similar to and as good as domestic rabbit meat, but the

abdominal muscles had an unpleasant, rat-viscera taste. This fact may account for several reports in the literature that the meat is inedible. Schmidt (1945) even mentions a belief among the natives of southern Peru that the tip of the tail contains a deadly poison which infects the whole carcass if not cut off immediately when the animal is killed.

A remarkable use for viscachas is mentioned by Cabrera and Yepes (1940). They state that it is customary to suspend living viscachas in the churches at Christmas time near Cuzco, in southern Peru.

We were told that viscachas could be sold in the town of Ilave for one or two soles, which was somewhat less than a day's wage for a laborer at that time, and skins sold for about forty centavos, the price of a pound of rice.

Viscachas enjoy the security of living in a barren land of few guns and have the good fortune to occupy cliffs and rockpiles which man does not covet. Since viscachas do not venture far from their rocks, they do not compete appreciably with grazing animals, and grazing (aside from mining, on which viscachas have no effect) is the most important commerce in the viscacha country. It is hard to imagine that they could ever become widespread nuisances unless as hosts or reservoirs of some parasite important to man or his livestock. Viscachas are so easily shot and trapped that if man so wished he could readily reduce them from one of the most abundant mammals of the high Andes to one of the rarest. Meanwhile, their thin wild whistle and cheering presence will be welcomed by shepherds and travelers in a barren realm.

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[Contribution from the Biological Laboratories, Harvard University]

Museum of Vertebrate Zoology, University of California, Berkeley 4, Calif. Received November 11, 1947.

BURROWS AND FEEDING OF THE NORWAY RAT

By Rocci G. Pisano and Tracy I. Storer

Norway rats dig innumerable tunnels and thousands of rat holes are gassed yearly in control by man, but few or none of the burrows of this rodent have been described or illustrated. This is a striking contrast to the considerable knowledge in print about the living quarters of less ubiquitous or less important rodents.

The burrowing and feeding habits of Norway rats (*Rattus norvegicus*) were studied in poultry yards at Davis, California, from late June to mid-September, 1947. The yards were thirty feet or more wide and separated by wire fences of large mesh, with 12-inch base boards. Some yards had concrete-floored houses for the poultry. Every yard had a drinking fountain with water dripping into a bucket. The overflow drained through a slatted platform supported on a concrete-walled drainage box, the bottom of which was filled with loose gravel (not floored with concrete). Most of the yards were covered with dense mats of dried grasses, weeds, and barley, all with abundant mature seeds. For the first few weeks of the study these plants furnished the bulk of the food for the rats. Later, turkeys were fed in some pens, and the rats then levied on the feed for the birds. The rodents also had access to cereal feeds in one or more of the poultry houses. During the entire period there was no rain, night temperatures were moderate (around 60°F.), and the only predators were barn owls (*Tyto*), gopher snakes (*Pituophis*), and an occasional house cat.

It is possible that the habits and burrows of *norvegicus* differ in other localities and climates, especially where the winter is cold or the rainfall heavy.

In the studies here reported, made in midsummer, post-mortem dissection of about twelve adult females and of several males revealed no evidence of breeding. No young or evidences of young were found in nests, and the smallest free-ranging individual trapped weighed 58.5 grams. The enlarged compartments in burrows

therefore are termed "dens," as they probably are used by adults as resting places.

Burrows.—In general, burrows were of three sorts, depending upon location. Around the drainage boxes the systems (Fig. 2) were short and had more than one den enlargement and underground shucking stations. Those in open parts of the yards often were longer (but not always) and had commonly only one den, and the shucking stations were usually outside (Fig. 1). The length of burrow under stacks of boards, diagonal fence braces, or floors was conditioned by the amount of such surface protection available (Fig. 3).

Of thirty-four burrows dug out for study, thirty-one were 36 inches or less in total length, one was only 18 inches, and the longest was 78 inches. The deepest one (part of an old ground squirrel tunnel) extended to 18 inches below ground, but the majority were 12 inches or less below the surface. All tunnels excavated were in the yards. (No attempt was made to excavate any burrows under the cement floors in poultry houses, where several rats were living.) When dug out, the tunnels proved to average about 2 to 2.5 inches in diameter. Several had short lateral blind branches, sometimes packed with plant debris. There was no evidence of food storage, but two tunnels contained many pieces of barley stems that had been cut in short lengths and carried underground by the rats.

Entrances.—Every tunnel had one or more entrances (E in figures) which were associated with any or all of the following above ground markers: (a) a runway 2 to 2.5 inches wide leading out into the dry vegetation and identifiable by trampled grass or packed soil; (b) a shucking station; or (c) a low somewhat crescentic mound of loose excavated soil. This soil soon becomes scattered and rarely remains so conspicuous as the mounds at entrances to the burrows of ground squirrels and some other rodents.

Bolt holes.—Each burrow had one or more emergency exits or "bolt holes" (B in illustrations) through which the rat could escape when unable to use a main entrance. In several instances, when burrows were gassed, the rat occupant was seen to emerge through a bolt hole. In routine control operations, rats may escape unseen from these holes. From exterior view, bolt holes were inconspicuous or well hidden, being variously: (a) open but covered by weeds; (b) loosely plugged with soil; or (c) covered by about one-fourth inch of undisturbed soil (or a mat of vegetation) that could be easily pushed out by a departing rat—as was seen in one case. Each bolt hole was at the end of a short lateral from the main burrow, usually from the roof of a den.

Dens.—Forty-six dens were found. There was at least one and sometimes two per burrow (D in figures). These averaged 5 x 6 inches in area and 6 inches in height at the center, being roughly spherical in shape; a few were larger. Most dens had a thin, orderly flooring of grass stems, leaves, and uniformly placed barley chaff; a few were unlined and three contained well-made nests, mainly of interwoven plant materials.

The floor of a den was usually somewhat below the bottom of the main tunnel, two being 7 and 9 inches lower, respectively, but a few were slightly above the tunnel. Were these burrows flooded, the low dens would soon become filled,

but active rats could escape through bolt holes. No den was used as a toilet and only once were droppings found in a tunnel.

Shucking stations.—There were numerous "shucking stations" in secluded spots near runways or burrows, under mats of dried weeds, in small depressions under piled lumber or debris, and under shelter of stout diagonal fence braces

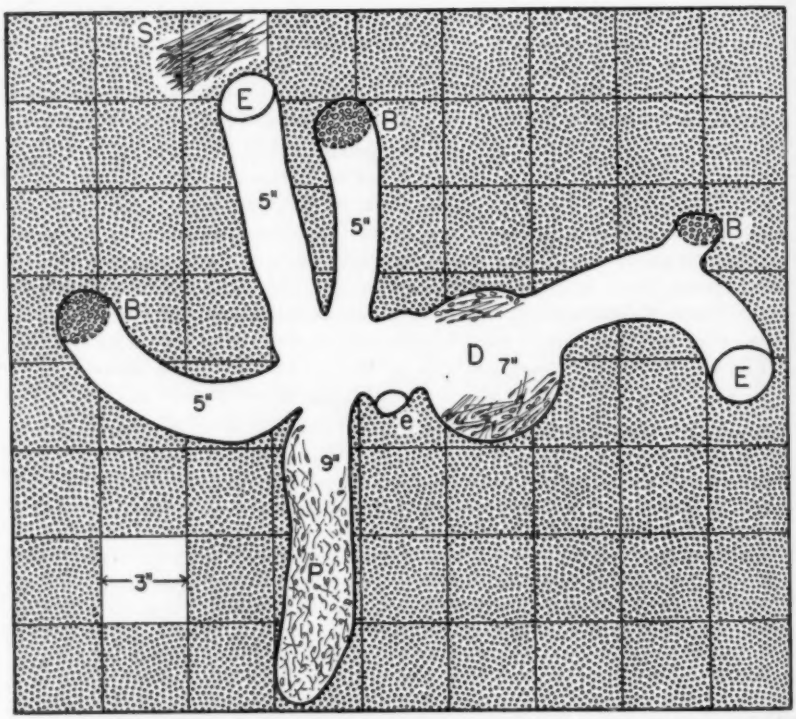

FIG. 1.—Plan of Norway rat burrow in grass and weed-covered poultry yard. Davis, Calif., July 3, 1947. E, open entrance; e, small opening; B, bolt hole, lightly closed with loose soil (sometimes under matted grass); D, den with food debris; P, blind tunnel packed with food debris; S, shucking station (another, 12 inches from entrance, not shown). Numerals are depths in inches to bottom of tunnels from surface of ground.

surrounded by vegetation. After having gathered a mouthful of seeds or a seed head afield, a rat returns to its shucking station to husk and consume its food in greater security. The station corresponds to a kitchen midden, marked by the debris of previous meals—a pile of seed coats, barley awns, or like material. Watched in both field and laboratory while hulling and consuming food, the rat sits on its haunches and grasps the food in its fore paws. Starting on a seed head at the stem end, as each seed is pulled off, the rat turns sideways and

drops the chaff; this results in an orderly stack. From heads of barley the awns were heaped in parallel pattern. Repeated feedings at the same station result in piles of debris 6 to 12 inches in diameter (Pl. I,A). Casual observations elsewhere have revealed shucking stations of indoor rats that retire beneath a low shelf or similarly sheltered place to leave remnants of nut shells or other meals.

In enlarged compartments of some burrows there were accumulations of barley

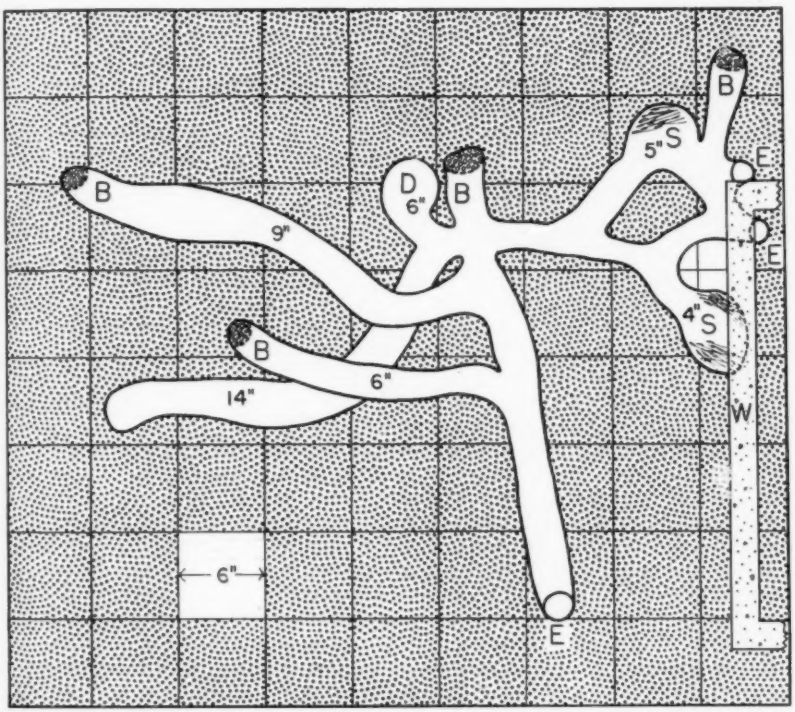

FIG. 2.—Plan of Norway rat burrow at edge of watering place (W) in poultry yard. Davis, Calif., July 8, 1947. Legend as in Fig. 1.

awns, etc., that looked like shucking stations located below ground (Fig. 2, S) for greater safety. Some lateral tunnels were shoved full of such debris (Fig. 1, P), possibly the accumulated residues of much below-ground shucking.

Runways.—Surface runs extended along the bases of most fences; others led directly from burrow entrances out into the dense dry plant cover in the yards. Often these branched where the rats had visited first one source of food and then another, or had made routes to a water supply. The runways generally took advantage of any vegetation present as cover, and parts of some runs were tunneled beneath the matted plants.

PLATE I

Norway rat. A: Barley spikes and other plant debris from a shucking station near a field burrow. B: Tunnel dug by female rat in box filled with soil; the cat, penned with mother, is seen in C and D.

Norway rat. A: Barley spikes and other plant debris from a shucking station near a field burrow. B: Tunnel dug by female rat in box filled with soil; the rat, gassed with carbon disulfide, is seen in C and D.

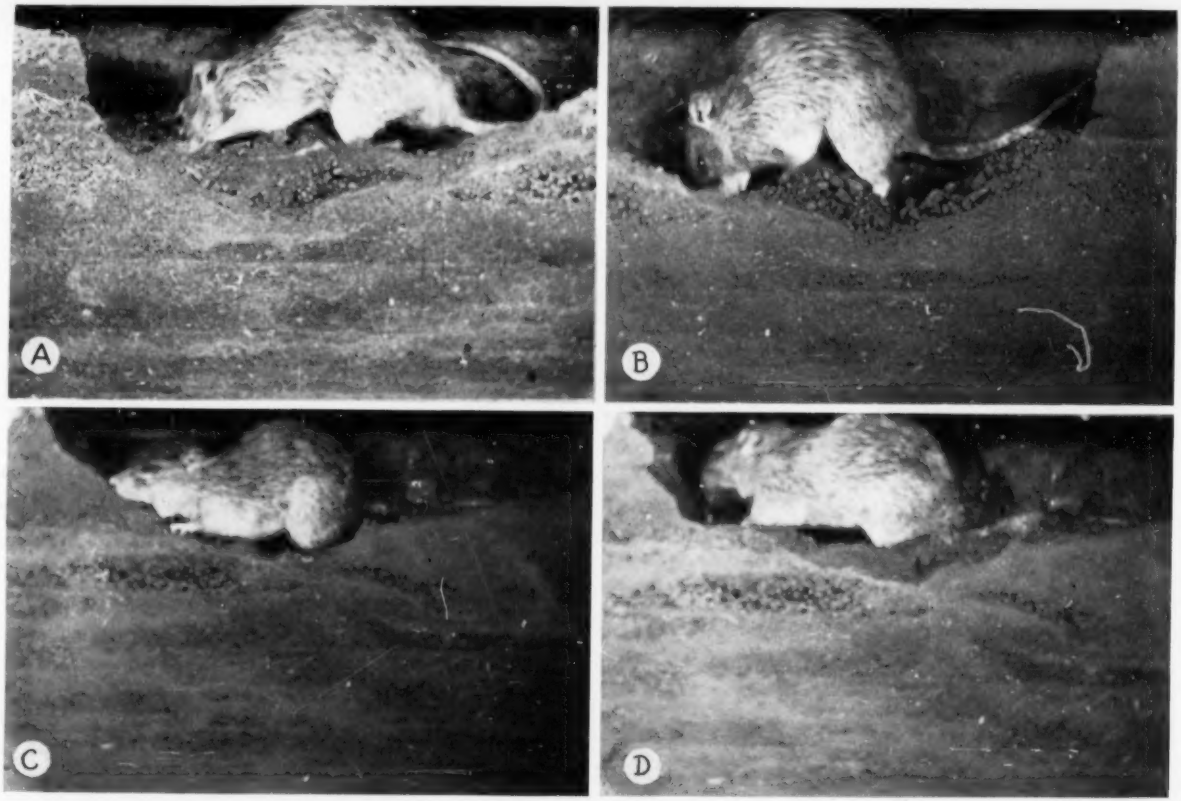

PLATE II

Norway rat excavating a burrow in an observation case. A: Pulling loosened soil under body with front feet. B: Body arched, ready to kick soil back with hind feet. C: Biting soil while excavating. D: Carrying small rock in teeth.

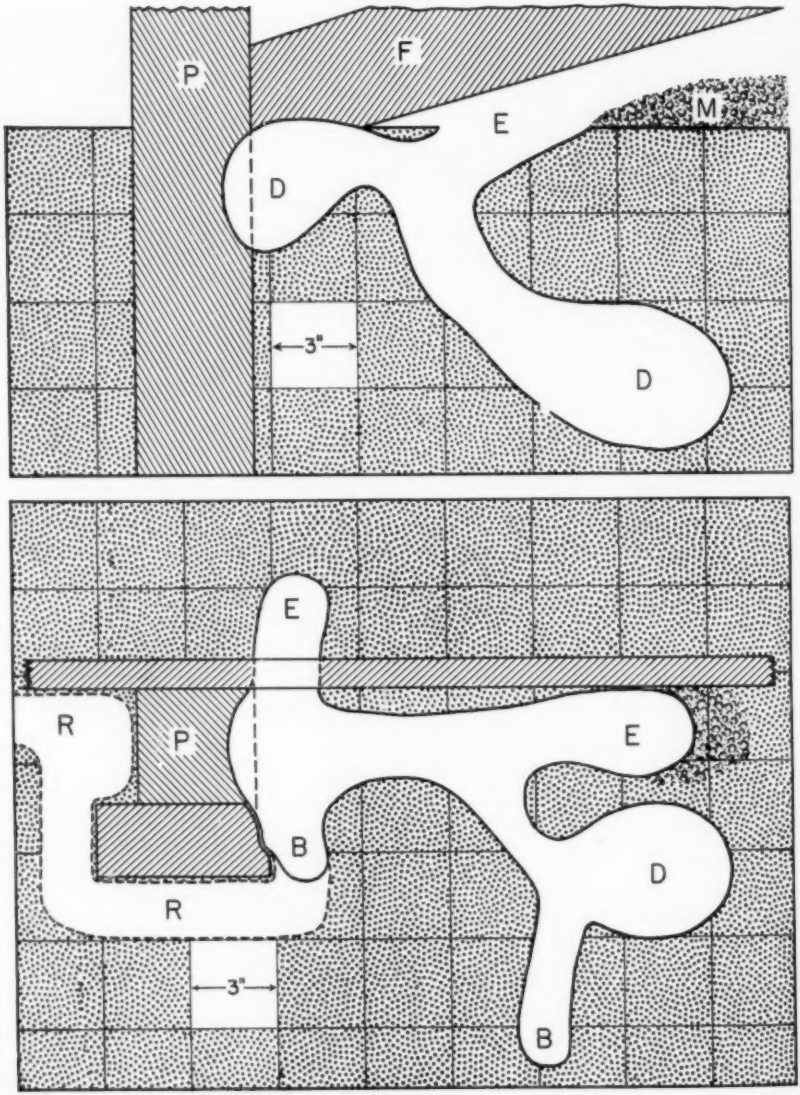

FIG. 3.—Elevation and plan of simple burrow of Norway rat sheltered under fence brace. Davis, Calif., July, 1947. F, fence brace; P, post; M, mound of excavated soil at entrance; R, runway; other legend as in Fig. 1.

Tunnel making.—To learn the manner and rate of digging a new tunnel, we gave a rat facilities to demonstrate in the laboratory. A stout wooden box,

48 x 22 x 12 inches, lined with corrugated cardboard, was packed full of soil (Pl. I, B–D). A 3 x 7-inch hole was cut centrally in the top and a wild adult female Norway rat was placed in a bottomless screen cage (24 x 18 x18 inches) over the hole. Immediately she began to dig furiously, bringing soil up through the hole; as soon as the tunnel was large enough she disappeared within. Thereafter she remained in hiding by day (food and water were provided in the cage), but each morning, for the next five days, there was much new soil that had been pushed up into the cage during the preceding night. The entrance hole was open when first examined each morning, but would be plugged immediately when any noise was made nearby. Soil brought from below was pushed out of the front and sides of the sloping tunnel, never behind.

Each morning there were one to three small wet spots on the excavated soil in one corner of the cage, where the rat had urinated. The same general area was used repeatedly. Along one side of the cage, feces were scattered in the manner seen on runways in the field. Later examination of the burrow excavated in the box revealed no sign that any part had been used as a toilet.

On the ninth day, the box was gassed with carbon disulfide and the top and sides were removed to examine the burrow. The dead rat was in the farther den, her nose covered by her forefeet, both nose and feet had been pushed under some loose earth (Pl. I, C–D).

From the entrance, the burrow extended at a slight downward slope to one side of the box, then continued along that side and an end for a total length of about 36 inches. There were two dens, one close to the top of the soil and the other at the bottom, hence nearly 12 inches "below ground." Both dens had been crudely floored with strips of cardboard ripped from the box lining.

Compared with the field tunnels described earlier, this was typical in diameter, length, dens, etc. Inferentially, it probably is the type a rat would dig under a wood floor or concrete slab on the ground. (For demonstration of rat work during a control campaign, the setup just described provides an easy means to obtain a rat burrow indoors.)

Methods in excavating.—To learn the exact method of digging (Pl. II), we placed a rat in an observation case 3.5 inches wide having glass sides 17 x 30 inches, and filled with slightly moistened soil.

Digging starts with rapid scratching and pulling movements of the front feet until a small pile of soil accumulates under the animal's chest. Further local movement of the loose soil is done in three different ways. (a) By rapid semicircular strokes of one or both front feet, the soil is forced aside; this sort of action at the burrow entrance scatters the soil in the crescentic form often seen. (b) The rat uses the fore feet to push the soil under its belly, then kicks the soil backward with powerful strokes of one or both hind feet. (c) The rat turns about in the burrow and pushes the soil back with either or both front feet.

The teeth are used to cut roots and to pull and carry out rocks, actually serving more than the front feet in breaking up firmly packed soil. When the rat has dug to a distance about equal to its body length, it turns around and pushes the loosened soil along the tunnel floor with piston-like strokes of the

front feet. The head assists in this pushing, sometimes with the mouth widely opened. At the burrow entrance the soil is scattered, as already described. The animal may also use its nose or head in scattering the soil.

While at work the rat stops periodically to lick and clean its feet, tail, and hair. Soil is swallowed while digging, and the feces of the experimental rats were firm with the contained soil for the several days while they were digging. Once digging ended, the soil content of the feces decreased and finally none was seen in the droppings.

Plugging the burrow entrance.—A rat in the observation case, after some digging at the tunnel end, turned and pushed some loose soil into the burrow entrance where it was compacted by use of the fore feet, nose, and head, either separately or in combination. This was continued until the entrance was fully blocked off—then the rat curled up and fell asleep. She remained asleep in this plugged tunnel (which was about nine inches below the surface and enclosed by firmly packed damp soil) for slightly more than five hours. The plugged burrow entrance so closely resembled that of plugged gopher burrows that it could easily have been mistaken for such in the field!

Daytime activities.—Few people were around the poultry yards by day, and for a month or so there were no fowl in the immediate area where these studies were made. Contrary to normal expectations, there was much daytime activity by the Norway rats; this condition continued for several weeks, but the amount of above-ground activity by day decreased with the frequent presence of the observer. The gradual reduction in total number of burrows as the latter were excavated, and trapping to obtain specimens probably influenced the situation.

From late June to early August the observer spent most of the day in one or another pen and saw rats at various hours (even in early afternoon) while they were feeding above ground and drinking at poultry fountains. If the observer remained quiet in one place, he soon heard rustling in the dry vegetation as the rats went about in quest of seeds. They sometimes crossed open roadways about ten feet wide between the yards.

On one occasion two rats were observed during midmorning continuously for forty-five minutes as they ranged in a radius of about sixty feet from a burrow, collecting seed and seed heads. Occasionally they would climb dry mustard stalks to a height of two to three feet above ground to clip barley from plants entangled with the mustard. The same two rats later climbed four or five feet up the trunk of a black walnut where they picked out and ate some undetermined small items from the bark crevices.

When rats foraging more or less in the open were frightened, and darted for shelter, quite a number were seen to bump head first into fence boards or the foundations of buildings, when there was a definitely audible thud. One evidently hit so hard as to be dazed momentarily, others changed course after bumping, and some turned quickly enough so as to strike only with the hinder part of the body. An occasional rat bumped more than once when closely and persistently pursued by the observer. Under such conditions, one rat ran and bumped into a turkey feed trough, then paralleled the box and escaped into a

burrow beneath the feeder. Frightened from this retreat, it ran to another trough, bumped again, and took shelter. This was repeated four times in all. After a rat struck a wall, it galloped beside the latter and seemed to know at once where to seek safety. This behavior supports the oft-repeated statement that vision is poor in Norway rats. Several rats that bolted from burrows when carbon disulfide was applied, behaved similarly. Once beside a wall, use of the vibrissae for contact enabled the rodents to travel rapidly and with greater certainty.

Feeding in captivity.—Contrary to some statements in the literature, several of the rats trapped alive and taken at once into the laboratory (where people were present) took food and water almost as soon as offered. Once satisfied, however, they did not again feed while observers were present, although water was taken. It is possible that such animals had been trapped early the night before and were hungrier than usual when first placed in the laboratory. Captives kept indoors for some time fed by day, but usually stopped eating the instant a person came into view.

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FUR CHARACTERISTICS OF TWO EASTERN RACCOONS

By Herbert L. Dozier, Thora M. Plitt Hardy, and Merle H. Markley

During recent years a very heavy build-up in the raccoon (*Procyon lotor*) population has been reported on many widely scattered Federal and State game refuges. The problem of raccoon predation on waterfowl, muskrats, quail, and many other forms of wildlife has therefore assumed increasing importance. The necessity for more accurate data on the distribution and food habits of the various races of this interesting and valuable fur animal for a better understanding of its management is at once apparent.

The raccoon is generally considered a creature of swampy woods or heavily timbered lowlands. Throughout its wide range, however, this animal occurs in many varied habitats. It is evident that long isolation and adjustment to environmental differences through climatic and genetic selection has caused it to vary considerably.

Dozier (1948) has recently shown that two different races of raccoons exist in the tidewater section of Delaware, Maryland, and Virginia—one inhabiting the swampy woods and ridges and the other the marsh areas. In differentiating the latter as a distinct, new race he found decided differences in size, structure, coloration, and pelage. This led to the establishment of a co-operative project between the U. S. Fur Animal Field Station and the Fur Fiber Laboratory of the Bureau of Animal Industry to determine if sufficient differences existed in the characteristics of fur fiber of the two closely related animals to be of real

diagnostic value. Although time available for this study has been limited, the results have been rather conclusive and show that the relative length, coloration, and quality of the fur can be employed to excellent advantage taxonomically in the case of the raccoon.

MATERIALS

Dressed pelts of twelve adult raccoons, six *Procyon l. lotor* (Linnaeus) and six *P. l. maritimus* Dozier, were obtained from the U. S. Fur Animal Field Station for microscopic, detailed study. They represented various localities in extreme eastern Maryland and Delaware (Table 1).

All pelts were taken during the late fall and winter months (November 13–February 24), a period when maximum hair growth and primeness had been attained. Although little more than passing mention of pelage changes and primeness of raccoon pelts has been found in the literature, several comments pertaining to primeness are of interest. During experimental breeding of raccoons, Bissonette and Csech (1937) noted that the animals did not shed their prime winter pelt until after the spring litters were produced. In a study of raccoon fur priming in Michigan, Steuwer (1942) found that the first evidence of molting of the prime coat did not occur until late April and May. The summer pelt is largely devoid of guard hairs. Growth of new guard hairs progresses during the fall until by mid-November most adults are found to be prime. Juvenile pelts apparently become prime even later than adults. Bailey (1926) stated that in North Dakota an open season from November 15 to March 15 would probably insure prime fur. Such observations emphasize the importance of utilizing only those pelts taken during the November–March period in order to accurately evaluate the fur fiber characteristics.

METHODS

Samples.—In order to obtain uniform data comparable to earlier published accounts on the hair characteristics of other mammals, fiber samples in all instances were taken adjacent to the mid-dorsal line at a point immediately anterior to the pelvic region. These were cut off as closely as possible to the skin with a fine-pointed, razor-sharp scalpel. As a rule, a sample consisted of 100 fibers of each type, taken from the tuft.

Fiber lengths.—Guard hairs and underfur fibers were mounted on plastic films cut to lantern slide size, as described by Hardy and Dolnick (1948). These fibers were projected to a magnification of ten diameters through use of an ordinary lantern slide projector. The images were measured with a metric scale.

Guard hair bands.—Film mounts of entire guard hairs were also used in measuring lengths of the various bands. For this purpose the lantern slide mount was placed on the stage of a wide field binocular microscope, using a piece of graph paper calibrated in millimeters as a background. By moving the lantern slide mount back and forth as desired, a direct reading in millimeters of each of the several guard hair bands was readily obtained. A combination of 10x oculars and 2x objectives was found to be satisfactory.

Cross sections.—Using the improved cross-sectioning device invented by Hardy (1935), cross sections were made according to the method described in detail by Hardy and Markley (1944). Guard hair cross-section measurements

TABLE 1.—*Raccoon guard hair length measurements; 100 fibers from mid-dorsal area of each pelt*

U.S.N.M. NUMBER	SEX	LOCALITY	DATE	GUARD HAIR MEASUREMENTS IN MILLIMETERS				PROJECTION OF GH/UF[1]	
				Tip	Subapical Band	Entire Fiber	Tip and Subapical Band	Millimeters	Per Cent
Procyon l. lotor									
275301	♂	St. Michaels, Md.	12– 4–46	8.95	11.02	43.24	19.97	12.08	38.77
275302	♂	Chestertown, Md.	12– 4–46	9.72	10.33	42.58	20.05	11.42	36.65
275689	♂	Bombay Hook Refuge, Smyrna, Del.	12– ?–46	8.74	10.26	40.93	19.00	9.77	31.35
275305	♂	Blackwater Refuge, Cambridge, Md.	2–24–45	10.39	10.58	41.66	20.97	10.50	33.68
275688	♀	Patuxent Refuge, Laurel, Md.	12–10–43	11.32	7.34	43.75	18.66	12.59	40.39
275684	♂	Blackwater Refuge, Cambridge, Md.	12–16–39	9.43	9.87	46.65	19.30	15.49	49.70
Averages				9.76	9.90	43.13	19.65	11.97	38.41
Procyon l. maritimus									
275325	♂	Blackwater Refuge, Cambridge, Md.	11–20–39	11.26	19.50	57.40	30.76	25.11	77.76
275310	♀	Blackwater Refuge, Cambridge, Md.	11–13–46	12.45	11.36	51.47	23.81	19.18	59.40
275289	♀	Blackwater Refuge, Cambridge, Md.	12– 3–46	11.95	13.36	50.15	25.31	17.86	55.31
275290	♀	Blackwater Refuge, Cambridge, Md.	12– 3–46	7.68	12.73	47.25	20.41	14.96	46.33
275298	♂	Rehoboth Bay, Del.	1– 6–47	11.67	12.63	53.58	24.30	21.29	65.93
275291	♀	Blackwater Refuge, Cambridge, Md.	1–22–47	10.01	13.26	49.13	23.27	16.84	52.15
Averages				10.83	13.80	51.50	24.64	19.21	59.49

[1] In determining the projection of guard hairs beyond the underfur tips, the following average underfur lengths were used: Eastern race, 31.16 mm.; Coastal marsh race, 32.29 mm.

were made through the maximum diameter of the hair shaft, which in the raccoon has been found to occur within the light colored subapical band.

Average diameters of underfur fibers were obtained from cross sections made one centimeter above the skin level. Cross sections of the fibers were projected at a magnification of 500x and measured with the improved bidiameter scale

according to the method of Hardy and Wolf (1939). In measuring both underfur and guard hair fibers, two diameters, at right angles to each other, were recorded. This method was necessitated by the elliptical shape of some of the fibers, and the measurements have therefore been listed as major and minor diameters. Medullary diameters are given for guard hairs only, as the medulla was found to be either absent or fragmentary (discontinuous) in underfur fibers.

Density.—Through accurate cutting and removal of two-millimeter square areas of skin with the fur attached and subsequent cross-sectioning of these fibers at one centimeter above the skin level, it was possible to determine the number of guard hairs and underfur fibers per square millimeter of skin area. The same figures were also used to ascertain the proportion of guard hairs to underfur, referred to in this paper as the guard hair to underfur ratio.

TYPICAL FIBERS

Guard hairs.—Raccoon guard hairs are of a type described by Toldt (1935) as multiple banded agouti hairs, consisting of the barring of the hair in several alternate dark and light bands. The dark appearance of our typical eastern race (*lotor*) is caused by the densely pigmented, long, black tips of the guard hairs. The lighter appearance of hairs on the lower sides and ventral surface results from white tipping of the guard hairs and their more scattered distribution in those areas.

Fiber lengths may be variable or quite uniform on prime pelts taken from the same locality. Brown (1942), in describing the pelt of *P. l. lotor*, stated that the average guard hair length was about 40 mm., occasionally reaching 60 mm. Guard hairs are fairly stiff and bristle-like, and are longer, straighter, and more robust throughout their length than underfur fibers. The usual form of the guard hair is fusiform or spindle-shaped, the maximum diameter being within the distal half of the fiber (in the subapical band in the raccoon) and tapering towards both base and tip.

The raccoon guard hair in cross section is usually oval or elliptical. The cortex is thick; the medulla is continuous, with the medullary cells varying in size and shape. As noted by Brown (1942), these cell forms give the impression that the medulla is a froth composed of various-sized bubbles. He also found that the pigment granules of the cortex were crowded around the periphery of the medulla, while the medullary pigment appeared intracellular in nature.

Underfur fibers.—Underfur fibers are the finest hairs on the raccoon pelt; in this study, the average diameter was found to be about 32 microns. Numerically, these make up more than 90 per cent of the entire coat. Their average total length, 20–30 mm. according to Brown (1942), is distinctly shorter than that of guard hairs on a prime pelt, and the fibers are always wavy or crimped except at the very tip. The color is usually a tan or light brown with the intensity of pigmentation gradually decreasing from the tip towards the base. Extending from the base or skin level, 1–3 mm. outwards or approximately the basal one-tenth of the hair, the underfur coloration may be so light as to appear entirely devoid of pigmentation. In no instances were the underfur fibers

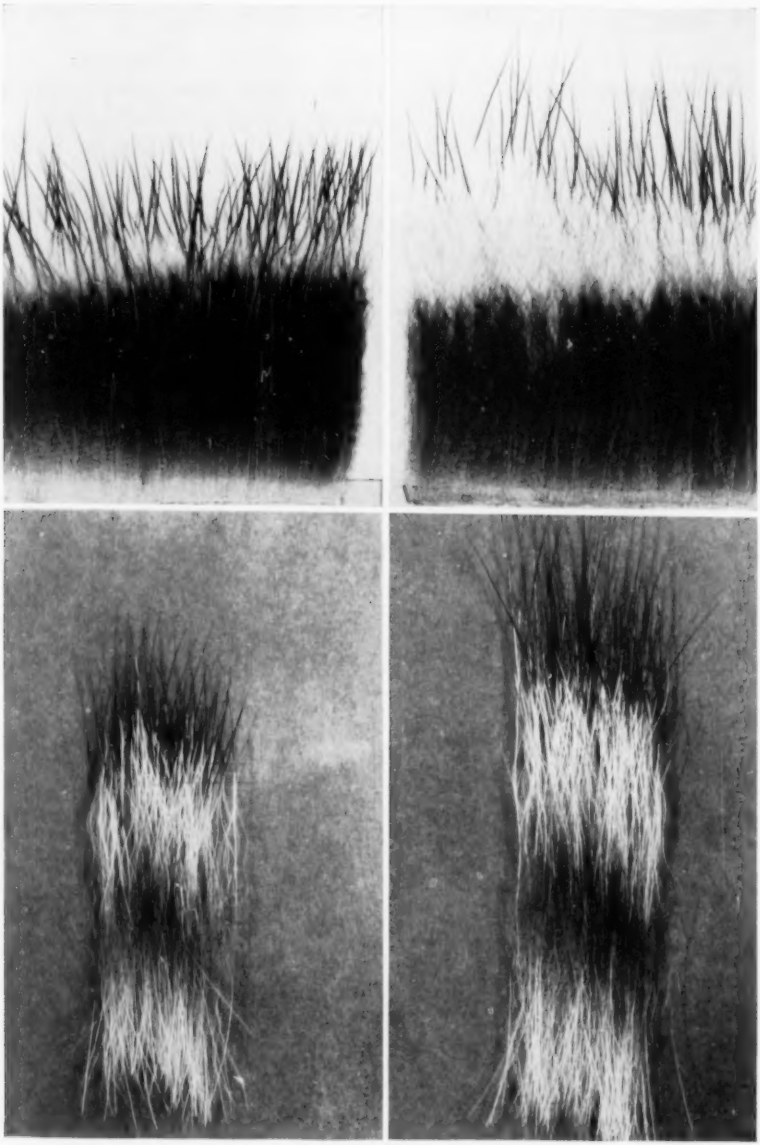

PLATE I

UPPER: Sections of skin with the fur attached of the eastern raccoon, *Procyon l. lotor* (Linnaeus) (left), and the coastal marsh raccoon, *Procyon l. maritimus* Dozier (right), showing differences in general appearance. Actual size.

LOWER: Tufts of guard hairs, *Procyon l. lotor* (left), and *Procyon l. maritimus* (right), showing differences in total length and that of the bands. Enlarged twice.

found to be banded, coinciding with Toldt's (1935) observations on the raccoon. Viewed longitudinally, the sides of the hair appear practically parallel. In cross sections, made one centimeter above the skin level, the underfur is uniformly round with pigment evenly distributed throughout the cortex. Medullated fibers were seldom observed at this level. In the study made by Brown

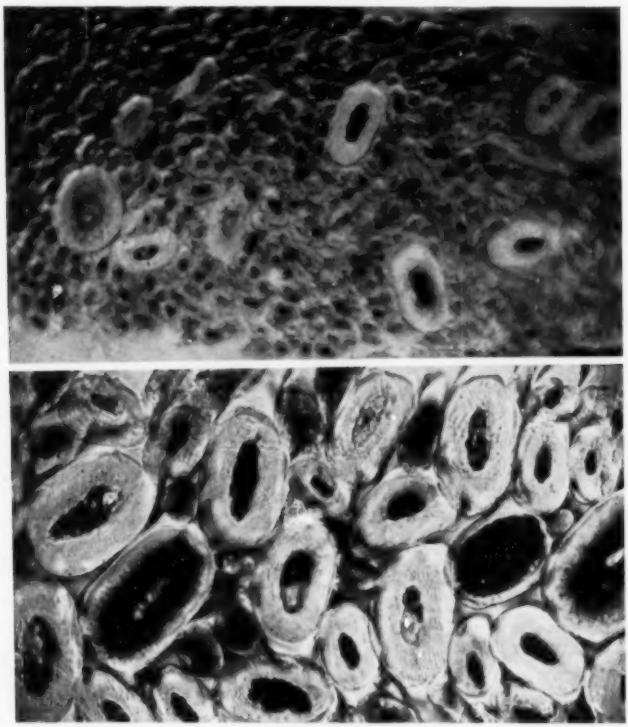

PLATE II

UPPER: Cross section of fur of *Procyon l. lotor* 1 cm. above the skin, showing characteristic appearance of guard hairs and underfur fibers. × 200.

LOWER: Cross section of guard hairs, *Procyon l. lotor*, cut through the subapical band. × 200.

(1942), the medulla was found to be usually absent (90 per cent) or highly fragmental (10 per cent). In comparison with guard hairs, underfur is much more uniform in color, diameter, and length.

RESULTS

Exploratory measurements.—One pelt, representative of each of the two races of raccoon, was selected for detailed microscopic analysis in order to discern

which characteristics, if any, would be of definite diagnostic value in the study of such closely related animals. Appreciable differences were noted in the total guard hair length, the length of the subapical band, and the guard hair density. Therefore, these measurements were taken on the entire series of twelve pelts.

Differences in the following characteristics were found to be too slight to warrant further work on the other pelts at the present time: (1) total length of underfur, (2) major and minor diameters of the underfur fibers one centimeter above the skin level (Pl. II, Upper), and (3) major and minor diameters of the guard hairs and of the medullae in the level of maximum fiber width, that is, within the subapical band (Pl. II, Lower).

Hair lengths.—Samples of 100 guard hairs each were taken from the mid-dorsal regions of six pelts of each race. These were cut off at skin level with a razor blade, embedded and dried in cellulose acetate plastic film, then mounted between glass lantern slides and projected at ten diameters for length measurements.

Guard hairs from the coastal marsh race (*maritimus*) averaged 51.50 mm. in length, the average of individual pelts ranging from 47.25–57.40 mm.; those of the eastern race (*lotor*) averaged 43.13 mm., individual pelts ranging from 40.93–46.65 mm. (Pl. I). Our findings with regard to the total length of the latter are in close agreement with Brown's (1942) average figure of about 40 mm. In the entire series of twelve pelts studied, no overlapping occurred between maximum guard hair lengths of *lotor* and minimum lengths of *maritimus* (Table 1). The dividing line between the two races occurred at about 47 mm. The average lengths given show that guard hairs of the coastal marsh race are 19.4 per cent longer than those of the eastern race. On the other hand, Grinnell, Dixon, and Linsdale (1937) determined the average guard hair length of raccoons from California, *Procyon l. psora*, which also occurs in a similar marshy habitat, to be two inches (50.8 mm.); this closely approaches the average of our coastal marsh race.

Guard hair bands.—The most striking difference in appearance between *lotor* and *maritimus* is the lighter color of the latter, revealed by a much more prominent, light subapical band. Only one reference to lengths of guard hair bands in raccoons has been found in the literature. Grinnell, Dixon, and Linsdale (1937) stated that in *P. l. psora* guard hairs from the mid-dorsal area are marked by three color bands. The apical band or tip was $\frac{1}{2}$ inch (12.7 mm.) long and blackish brown; the subapical band was $\frac{5}{8}$ inch (15.9 mm.) long and whitish; and the basal band was $\frac{7}{8}$ inch (22.2 mm.) long and brown.

In the two eastern races the majority of the guard hairs was found to have three distinct color bands, described as follows: (1) a dark brownish or black tip; (2) a very lightly pigmented subapical band, either whitish, translucent, pale yellow, or tan; and (3) a third brownish band, much less densely pigmented than the tip. Towards the bases, the hairs gradually become lighter in color. Only the two most distal bands (tip and subapical) project beyond the underfur. The basal portion, therefore, exerts little influence upon the color, texture, or general appearance of the outer pelage.

Average lengths of the tips and subapical bands, based on 100 guard hairs

from each pelt, are given in Table 1. In the coastal marsh race the tips averaged 1.07 mm.—approximately 11 per cent longer than those of the eastern race. Subapical band lengths gave a difference of 3.9 mm., an increase of over 39 per cent in length for coastal marsh raccoons. Subtracting the two distal band lengths from the total guard hair lengths, it was found that the remaining proximal or basal portion of the guard hairs of the coastal marsh race was 14 per cent longer than in *lotor*.

The above observations would seem to indicate that in the race *maritimus* the entire hair shaft has been lengthened and, further, that such elongation is also discernible in each of the several component bands. These determinations are in agreement with the statement made by Toldt (1935: 116) that in general longer hairs tend to possess longer or wider bands. However, it is evident from

TABLE 2.—*Raccoon guard hair density. Counts made on twenty square millimeter areas of skin from the mid-dorsal region*

PROCYON L. LOTOR			PROCYON L. MARITIMUS		
U.S.N.M. Number	Total Guard Hairs	Guard Hairs per Square Millimeter	U.S.N.M. Number	Total Guard Hairs	Guard Hairs per Square Millimeter
275301	80	4.00	275325	55	2.75
275302	79	3.95	275310	53	2.65
275689	92	4.60	275289	47	2.35
275305	87	4.35	275290	57	2.85
275688	67	3.35	275298	46	2.30
275684	71	3.55	275291	45	2.25
Averages....	79.33	3.97	Averages...	50.5	2.53

the present study that the major part of such elongation in coastal marsh raccoon fibers occurs within the subapical band.

Macroscopic measurements.—In addition to the detailed microscopic measurements taken on the series of twelve pelts, gross measurements of length were obtained on ten other adult pelts of each race. Average lengths of the guard hairs of adult *P. l. lotor* ranged from 41 mm. to 49 mm., with a combined average of approximately 44.9 mm., and the subapical band measured 9.8 mm.

Guard hairs of *P. l. maritimus* ranged in length from 48 mm. to 60 mm., averaging 52.8 mm., and the subapical band measured 14.0 mm. These results, obtained by measuring with an ordinary ruler, are in very close agreement with those obtained through more exacting microscopic study.

Fiber density.—A casual gross examination of raccoon pelage gives some indication of the relationship between the proportion of guard hairs to underfur fibers, for it is readily evident that the guard hair covering is sparse. However, in order to make an accurate determination of fiber density and the guard hair to underfur ratio per unit of skin area, cross-section counts of all fibers that occurred on an area of 20 square millimeters were made at a level one centimeter

above the skin. Because of the larger diameter of the guard hair, the two fiber types can be easily differentiated at this level when prime pelts are used (Pl. II).

Complete counts of cross-sectioned fibers were made on one pelt of each race of raccoon studied. The total count of 2117 fur fibers of the coastal marsh pelt gave a density of 105.85 fibers per square millimeter, of which 97.4 per cent was underfur, or a guard hair to underfur ratio of 1:37.5. The density of the eastern race, based on a total of 2252 fibers, was 112.6 fibers per square millimeter, 96.4 per cent being underfur, with a guard hair to underfur ratio of 1:27.2. If the eastern race pelt is used as a standard for comparison, the data given exhibit the following trends: the pelt of the coastal marsh race contains 31.2 per cent less guard hairs, 5.1 per cent less underfur, and 6.0 per cent less total fibers per unit area in the mid-dorsal region.

This preliminary examination indicated that the number of guard hairs per square millimeter offered the most variable or divergent results and was therefore selected as the best basis for further study of possible density differences. Additional macroscopic counts, based on guard hairs only of the entire pelt series, verified the existence of racial differences in guard hair density.

Data on the twelve pelts examined (Table 2) shows that the guard hair coverage in *maritimus* was more sparse, containing 36.3 per cent less guard hairs than raccoons of the eastern race. Apparently, there are less than three guard hairs per square millimeter on the average in fur of coastal marsh raccoons, but more than this in eastern raccoons.

DISCUSSION

The present microscopic studies of pelts of the eastern and coastal marsh raccoons substantiate the striking differences in appearance of the two races. The lighter color of the coastal marsh raccoon can be attributed mainly to certain characteristics of the guard hairs. The total length of the guard hairs of the coastal marsh race is 19.4 per cent greater than that of the common eastern race. Further, the black tips of the former exceed those of the latter by 11 per cent; and most important, the subapical band is 39.4 per cent longer. Consequently, the combined tip and prominent subapical band in the coastal marsh form project 21.1 per cent farther beyond the underfur than in the fur of the eastern race, thereby making the pelage appear distinctly lighter in color.

Grinnell, Dixon, and Linsdale (1937), in describing the pelage of a very pale race, *Procyon l. pallidus*, from the Colorado desert of southeastern California, call attention to the following characteristics as being responsible for paler coloration: (1) a much smaller amount of black on individual guard hairs occurs everywhere except on the nose and cheeks; (2) the black areas are smaller; (3) the "black" color of the guard hair tips in many places is not so intense; and finally, (4) the underfur is very much paler in intrinsic color.

The subapical band is located in the thickest portion (maximum diameter) of the guard hair and, as mentioned previously, is longer in the fur of the coastal marsh race than in that of the eastern raccoon. These characteristics of the

guard hairs in combination with their greater projection over the underfur undoubtedly contribute to the coarser texture of the fur of the coastal marsh race.

SUMMARY

Combinations of certain microscopic characteristics of the fur fibers can be used to differentiate between two races of raccoon: the common eastern raccoon, *Procyon l. lotor* (Linnaeus), and the coastal marsh raccoon, *Procyon l. maritimus* Dozier.

1. Guard hairs of *maritimus* were 19.4 per cent longer than those of *lotor*.

2. Such elongation was also found to occur in each of the several guard hair bands. However, the major part of this lengthening in *maritimus* took place within the subapical band.

3. The lighter color of *maritimus* was found to be due primarily to the more prominent, pale subapical band which is more exposed and projects farther beyond the underfur than in *lotor*.

4. The coastal marsh race contained 36.3 per cent less guard hairs per square millimeter of skin area than did *lotor*. This decreased guard hair density contributes to the uneven appearance of the pelage.

5. The two races were found to be quite similar with respect to cross-section diameter-measurements of guard hairs, guard hair medullae and underfur fibers.

6. Little variation in underfur density and average lengths was found in the two races studied.

After this investigation was completed it was found that Longhurst and Chattin (1941) have published diagrams of hairs taken from six races of black-tailed deer. These also show different proportions of tip, light band, and dark band above the light-colored base.

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COLOR MUTATIONS IN THE MUSKRAT (*ONDATRA Z. MACRODON*) AND THEIR INHERITANCE

BY HERBERT L. DOZIER

Hollister (1911) has shown that all existing forms of muskrats are closely related, being mostly geographic races of one widely distributed species, *Ondatra zibethica*. All apparently have what in genetic terminology is a *black agouti* coat (*ABC*) resulting from the joint action of three independent and dominant genes, (1) *A*, an agouti or wild type coat pattern gene, (2) *B*, a gene conditioning production of black pigment as the darkest element of the coat, and (3) *C*, a gene for the development of full color, a recessive mutation which would result in some type of albinism.

To the ordinary observer the general coloration of most wild muskrats is a mahogany brown varying in intensity from pale reddish brown to a grayish brown or blackish brown dorsum, the underparts distinctly lighter in color and with a line of demarcation often quite sharp.

Since the establishment of the U. S. Fur Animal Field Station on the Blackwater National Wildlife Refuge, near Cambridge, Maryland, in the fall of 1937, particular attention has been given to the color phases and variants of the Virginia or coastal muskrat, *Ondatra z. macrodon* (Pl. I). The normal color phase of this race is a rich brown with considerable bright russet to red tinge, darker on the nose, head, and back. The sides are grayish brown to russet and the underparts are considerably lighter, varying from grayish drab to a bright cinnamon rufous. While considerable differences may occur, both the trapper and the fur-buyer class these indiscriminately as "red" or "brown" muskrats.

A black color phase occurs commonly throughout the range of this race (Dozier & Allen, 1942; Dozier, 1944) and in some Maryland and Virginia marshes this may run as high as 65 per cent of the population. Trappers of these sections often speak of marshes as being either "black" or "red,". depending on the abundance of the two color phases. The so-called "black muskrats" are not uniformly black all over and devoid of the agouti hair pattern, as are black rabbits, rats, mice, and guinea pigs. Black animals of the latter sort are known as *non-agouti blacks* since they lack the wild or agouti coat pattern, possessing a recessive allele of agouti, symbol *a*. But the "Maryland black" muskrat has a modified agouti pattern shown in the lighter ventral surfaces and on the lower

side areas where hairs subapically banded with yellow occur. The dorsum, however, is a uniform glossy black devoid of hairs banded with red or yellow. This pattern corresponds rather closely with the black-and-tan pattern of the domestic rabbit and the house mouse as described by Dunn (1928), a mutation given the symbol a^t, recessive to A (wild type agouti), but dominant to non-agouti (a).

A small series of breeding experiments reported by Smith (1938) indicated that the black type muskrat is recessive to brown. Later experiments on a much larger scale conducted by the writer at this Station confirm Smith's conclusion. Black-and-tan mated with black-and-tan has produced only black-and-tan offspring, whereas parents of the brown type may produce both types of offspring with browns usually in excess of black-and-tans. The Mendelian expectation is that a 3:1 ratio of brown to black-and-tan young would occur when heterozygous browns are mated together. Black-and-tan individuals accordingly are, as regards the agouti gene, a^ta^t in formula, and heterozygous browns are $A\ a^t$ in formula. Both sorts are homozygous for B and C. As regards the three fundamental color genes of mammals:

(1) Wild brown muskrats in general are	$AA\ BB\ CC$	
(2) Maryland muskrats where black as well as brown color phases occur are	$AA\ BB\ CC$	Brown
or	$A\ a^t\ BB\ CC$	Brown
or	$a^ta^t\ BB\ CC$	Black

Although a non-agouti black muskrat (aa), uniformly black all over, has not been observed on the Blackwater National Wildlife Refuge, two skins which answer to this description were obtained at Back Bay National Wildlife Refuge, Virginia, in 1943, together with a third skin showing lighter coloration on the flanks, but less in amount than that of ordinary black-and-tan individuals. It is thought that this last may be a heterozygote ($a^t\ a$) with a^t dominant over a as in mice and rabbits. The order of dominance of the three alleles would then be A dominant over a^t, which in turn is dominant over a.

According to Manager Jack E. Perkins, about fifteen non-agouti blacks (aa) were taken in 1944 on the Back Bay National Wildlife Refuge, Virginia, out of a total of 1289, of which 597 were black-and-tan and 425 brown, the remainder kits and culls. A report has also been received from Curtis Insley and his son Russell, local trappers who trapped the Gibbs marsh near Moyock, North Carolina, in 1944, that they took about fifty completely black muskrats, the first they had ever seen. It appears therefore that the non-agouti black mutant (aa), which in most mammals is much more common in occurrence than the black-and-tan (a^ta^t) mutant, has become established in certain Virginia and North Carolina marshes.

Fawn muskrats.—The designation "brown" as used in this paper does not imply the occurrence in muskrats of the recessive mutation (b) of the gene for black pigmentation (B). Such a brown mutation is well known in mice, rats, guinea pigs, rabbits, and dogs. Under this mutation the wild or agouti coat

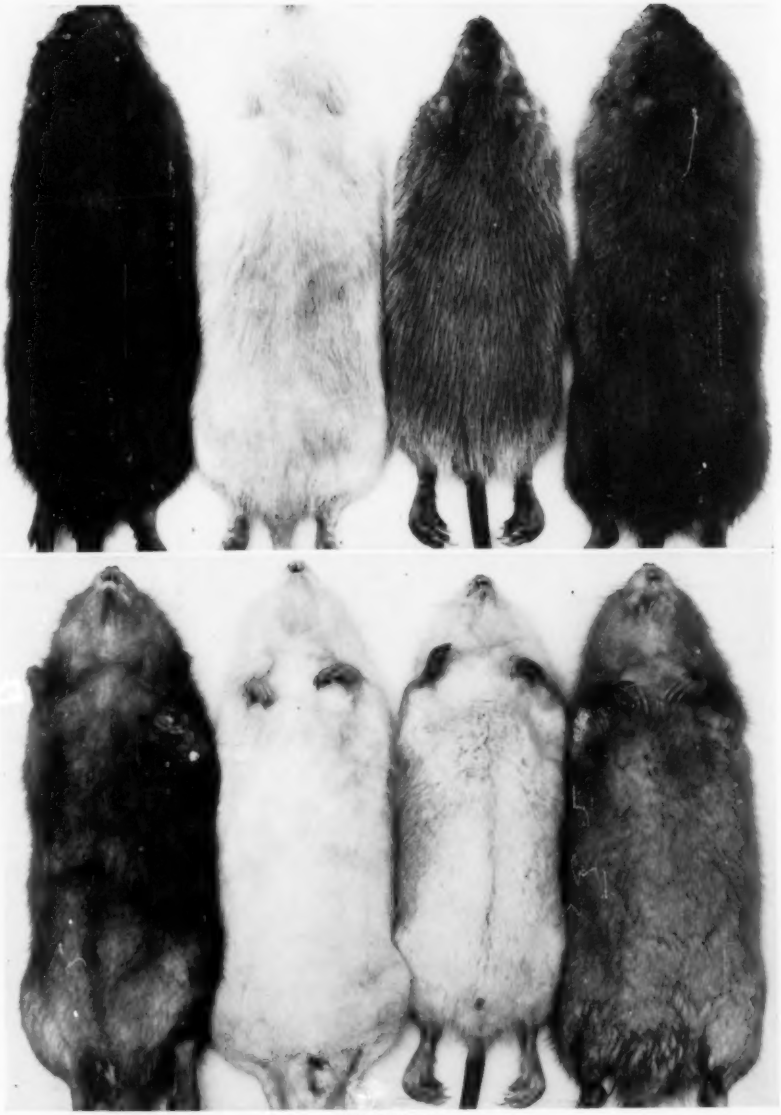

PLATE I

Color phases of the Virginia or coastal muskrat, *Ondatra z. macrodon*. Left to right: adult black-and-tan male; adult Maryland white male; subadult maltese gray male; and adult brown male.

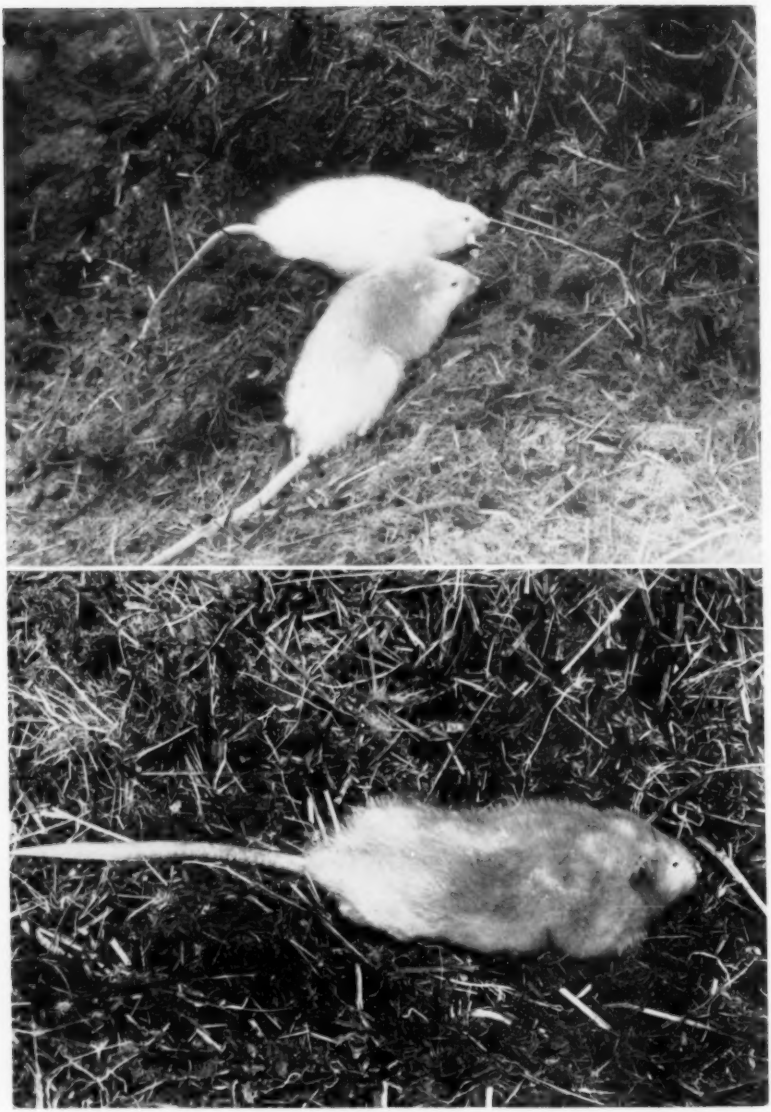

PLATE II

UPPER: View of pink-eyed albino male trapped by C. B. Stanton near Salem, N. J., Feb. 2, 1938, and smoky-white female (#60), trapped by Curtis Insley on the Blackwater Refuge, Md., Feb. 27, 1938.

LOWER: Fawn male caught alive in trap on Fairlee Creek near its Chesapeake Bay mouth, Kent County, Md. in March, 1941.

PLATE III

UPPER: Young maltese gray female taken by Preston Mills along World's End Creek on the Dean marsh near Golden Hill, Md., Jan. 5, 1938.

LOWER: Maryland white female (#84) with her litter of five-month-old brown young, sired by black-and-tan #31; litter born Sept. 18, 1940, and photographed Feb. 18, 1941.

pattern becomes cinnamon rather than gray (black agouti), and the non-agouti type (*aa bb*) becomes uniform chocolate rather than black. It may be that the *b* mutation in muskrats has merely been overlooked thus far among the lighter individuals classified as brown. There is a possibility, however, that it is really present in what have been called *fawn* individuals, a recurring mutation which has for several years been taken in the vicinity of Chestertown, Maryland.

In this variety, of which the writer has acquired some fifteen skins, the mid-dorsal area is close to "orange cinnamon" of Ridgway, shading off to "pink cinnamon" on the sides. The underfur of these skins is not a bluish or slate-gray as in ordinary wild "brown" muskrats, but is a very pale brown with a faint lavender tint. No black pigment is seen in hairs cleared in xylol and mounted in balsam. The genetic formula of such animals is presumably *bb* though there is a possibility that it may be *ee*. In all probability it differs by a single recessive gene mutation from the ordinary brown or black-and-tan types of muskrat.

If this mutant were thought to be of sufficient economic importance, the frequency of its occurrence might be increased by selective live-trapping of the marshes where it occurs, pelting ordinary individuals, and releasing fawn individuals as breeders.

A fawn male (No. 129), caught alive on Fairlee Creek near its Chesapeake Bay mouth, on the Russell G. D'Oench property near Mellitota Crossroads in Kent County, Maryland, by Millard Joiner in March, 1941, was secured by the Station Director for experimental breeding (Pl. II). This animal was a remarkably uniform fawn, lightening slightly along the sides and belly. The tail and feet were very pale. It became necessary to amputate its hind leg, due to its having been broken by the steel trap and becoming infected, and the leg was preserved for reference. This male died March 26, 1941.

According to Morgan Bennett, well-known marsh owner and fur-buyer of Chestertown, Maryland, the first observation of these fawn muskrats occurred about 1924 on the property of H. P. Skipper, below Chestertown on a small marsh bordering the Chester River. The marsh consisted of tall reed, narrow-leafed cat-tail, and rather poor three-square. Mr. Bennett rented and trapped this property from 1924–36. He has purchased most of the pelts from this area and from the surrounding country from 1924 to the present time. He reports trapping as high as four to six fawn muskrats annually out of a total of around 200 taken from the Skipper property.

Each year since 1924, three or four fawn muskrats have been trapped on the Larrimore property near Booker's Wharf in Queen Anne County. This marsh consists also of tall reed, cat-tail and some three-square.

During more recent years, this mutant seems to have spread along the Chester River to a few other properties. The "Hollow Marsh" of approximately ten acres, on the Riverside Farm of Dorsey Hines, just below Chestertown, has yielded a few in the past several years, also the Irving Walker marsh, just up the river from Chestertown, has produced a few during the last nine to ten years; none were known from there previously. Mr. Bennett states that no white or

smoky-white muskrats have ever been taken or reported from that area, or in Kent County, since 1924 when he first started his operations as a fur-buyer and trapper.

An alternative explanation of the fawn muskrats would be that they have the same genetic constitution as fawn rabbits, black pigment being greatly restricted in the coat and being found chiefly in the eyes and the skin of the feet, leaving the coat pigmented chiefly with yellow. Such a mutation is assumed to be recessive (*e*) in a genetic factor for *extension* (*E*) of black pigment throughout the coat, except where it is inhibited by the *A* factor. It is impossible at present to decide between the two interpretations of fawn in muskrats, viz., (1) mutation in *B* to *b* or (2) mutation in *E* to *e*, without microscopic examination of eye or skin pigments, which is not practicable in the pelts in hand.

White muskrats.—In the course of the present investigations two different kinds of white muskrats have been observed. One of these is the true pink-eyed albino with a wholly unpigmented coat, similar to the albino varieties of mice, rats, rabbits, *Peromyscus*, and other rodents, in all of which a mutation is assumed to have occurred in the color factor from the fully active state *C* to the completely inactive and recessive state *c*. Albinos breed true like other recessives, and colored animals heterozygous for albinism when mated together produce colored and albino offspring in the ratio of three colored to one albino. It may reasonably be assumed that the same is true of a race of muskrats in which the albino mutation has taken place. The albino gene will be carried along as an unseen recessive in the stock until such time as two individuals mate, both of which are carriers of the mutant gene, when they will produce litters in which on the average one fourth of the young are albinos.

The occurrence of albino muskrats has been authentically reported in at least three recognized subspecies, *zibethica*, *rivalicia*, and *macrodon*. The records are as follows:

Hollister (1911), in his discussion of *Ondatra z. zibethica*, stated that "several albinos and partial albinos have been examined." At rare intervals since that time other pink-eyed albinos have been reported over the range of this subspecies by Jackson (1938) and others. W. J. Hamilton, Jr., of Cornell University, informed the writer that he and a fellow trapper in 1918 caught eight pink-eyed albinos along Little Neck Bay on Long Island, New York, but that their occurrence in that State could be considered extremely rare.

A few limited pockets of white muskrats are also known for *Ondatra z. rivalicia*. One such pocket occurs in the Philip Traceland Section 19 along the Oak River in Plaquemines Parish, near Phoenix, Louisiana, according to Frank Musmeci who informed the writer that he and three other trappers caught sixty-eight pink-eyed whites there in 1938.

Only four definite records of the occurrence of pure white, pink-eyed albinos in the coastal subspecies, *Ondatra z. macrodon*, are known to the writer. The first of these was a 1-pound 15-ounce male that was taken alive in a steel trap by C. B. Stanton on a marsh near Salem, New Jersey, February 2, 1938. This animal was obtained by this Station for breeding purposes (Pl. II), but finally

succumbed, without progeny, to a leg injury sustained at the time of trapping. Out of a total of 83,804 muskrats taken on the Blackwater Refuge during the period 1938–44, only one pink-eyed white has been trapped. This was a male taken by Billie Insley in February, 1940, on the McGraws Island marsh. The specimen was mounted by a taxidermist for Mr. Wilbert Rawley of Leipsic, Delaware. According to John Lehn of the Animal Trap Company of America, a pure white, pink-eyed muskrat was trapped on March 6, 1940, at Woodland Beach near Smyrna, Delaware. The writer had the opportunity of examining closely a snow-white pelt from Salem County, New Jersey, that had been purchased by a fur-dealer in January, 1943. This animal was said to have had pink eyes.

The second kind of white muskrat which has been observed at the Blackwater Station has dark eyes and a pigmented coat when young. It represents a hitherto unrecorded mutation of the muskrat, the nature of which, with the manner of its inheritance, it is the major purpose of this paper to discuss.

Occurrence and distribution of the new Maryland white mutation.—A complete record has been kept by the writer from 1938 to the present time of all color variants of the muskrat that have occurred in the annual catch from the Blackwater Refuge, together with those coming to his attention from other marshes of the eastern shore. Most of the mutant animals have ranged in color from a beautiful maltese gray to an almost snow white. Their status was most puzzling until cleared up through breeding experiments that proved these to be gradations in development of one and the same hitherto unrecognized new mutation, which will be called Maryland white (*ww*) in this paper.

According to many old-time trappers, fur-dealers, and marsh owners familiar with this section, small "pockets" of white and smoky-white muskrats have persisted for many years on certain marshes, known as "Rhode Island," "Middle Ridge," and "McGraws Island," now embraced in the present Blackwater Refuge. In 1941, Joseph Willey, who has trapped these same marshes for years, informed the writer that such a "pocket," in about the same numbers as now, existed on "Rhode Island" marsh in 1891 when he was a boy of fifteen.

A second but smaller pocket is known to exist on the Dean marsh along World's End Creek, near Golden Hill, Maryland. An adult pair of smoky-white muskrats, together with a pair of immature maltese gray, were trapped from the same lodge by Preston Mills from January 2–5, 1938, along this creek, and a large white male was taken from the same area on February 25, 1938.

This mutation is also known to occur in the vicinity of Joe's Point, adjoining the Refuge "pocket," on the Gore and Garcia marshes near Robbins, the Mills Ditch marsh near Best Pitch Ferry, Guinea and Cedar Creek marshes near Fishing Bay, the Prettyman Gray marsh on Elliotts Island, and on the Joe Roberson marsh on Taylor's Island, all locations in Dorchester County, Maryland. There are only two records of the occurrence of this mutation outside of Dorchester County. A letter on file from L. E. Payne, Allen, Wicomico County, Maryland, dated March 1, 1932, states that he had live-trapped, only a few days before, a male muskrat that was gray on the back, white underneath, and

with pink nose, feet, and tail. The writer was informed by John Lehn of the Animal Trap Company of America that he had examined a maltese gray muskrat that had just been trapped by Isaac Cleaver of Middletown, Delaware, on March 5, 1940, along the road out of Odessa, Delaware.

It is readily apparent that the distribution and number of the Maryland white is rather limited and that dispersion has been slow. Unquestionably, predation has played an important role in its survival as such pale colored animals would be among the very first to be caught by hawks and owls.

During the 1938 season (January 1–March 15), representing the peak of abundance in the present cycle, 26,286 muskrats were trapped on the Blackwater Refuge. These consisted of 11,840 adult brown, 11,739 adult black-and-tan, and 2707 classified as kits and damaged. Included in the browns were only twenty-seven mutants, a ratio of slightly less than one per thousand. These consisted of one unsexed "maltese gray," seven male, five female, and five unsexed "smoky-white," and five male, three female, and one unsexed "white."

Of a total of 21,856 muskrats trapped on the same area in 1939, only two whites and three smoky-whites were reported. No specimen of this mutation was trapped in 1940. Of a total of 9895 muskrats trapped on the Refuge in 1941, only seven of this mutation were taken; one maltese gray male, two smoky-white males, one white female, two white males, and one unsexed white. No mutants were taken on the Refuge during the 1942 season and only a single male in 1943.

Description of the mutant.—It is quite evident that the mutation under discussion, which we shall hereafter call "Maryland white," is independent in origin and genetically distinct from the pink-eyed albino. Nothing quite comparable has previously been recorded. The nearest approach appears to be in the case of the Percheron horse where the colts may be born with dark coats and at the first shedding show interspersed white hairs. They become lighter in color each year until they are almost pure white about the twelfth year.

In this new mutation the young are a dark maltese gray, with the throat, sides, and underparts white (Pl. III). As they develop the color becomes lighter so that around the sixth month they might well be termed silver-gray. At that time the tail is still dark, but the feet appear distinctly lighter than normal. The color continues to lighten with age so that as breeding maturity approaches they become varying degrees of smoky-white (Pl. II). By the start of their second breeding year these mutants have become entirely white, except for some dark vibrissae and a small area of smoky black hairs situated towards the tip of the nose; the tail and feet have lost nearly all trace of pigmentation.

The eyes of the Maryland white appear dark on casual examination, but when the sunlight is permitted to shine directly into them, the color appears to be a very dark red and it becomes evident that a slight amount of pigment reduction has taken place.

Size of the Maryland white mutation.—According to Castle (1938) "Certain recessive mutant genes, when homozygous, increase the body size of mice, whereas other mutant genes decrease the body size." It is therefore of parti-

cular interest that the meager data available for the Maryland white tend to indicate that the average weight of this mutant is slightly above that of 2.23 pounds (1011.5 grams) reported for 4357 brown adult muskrats of both sexes trapped during 1941 on the same refuge (Dozier & Allen, 1942) and a similar average for 3102 brown adults in 1942 (Dozier, 1944).

The total weight of eighteen mutants was 653 ounces, an average of 2.27 pounds (1029.7 grams) per animal. Two others were not tabulated because they had been retained in captivity prior to weighing and succumbed shortly afterwards to injuries sustained in the steel traps. The largest specimen of this mutation known to date was a 3-pound 3-ounce white female, trapped by William Handley on Deadwoods marsh of the Blackwater Refuge, Maryland, January 28, 1941.

Breeding behavior.—The scarcity of the mutation, together with the fact that most of those taken have been either drowned or so badly injured in the steel traps that they do not survive, precludes the probability of obtaining many of them for experimental breeding purposes. Through the friendly co-operation of a number of trappers and marsh owners, the writer was able to obtain a small number of these alive during the peak years of their abundance in 1938 and 1939, but the majority succumbed without progeny. Successful matings of these mutants were not secured until the 1940 breeding season when five litters were produced in our marsh inclosures.

Under confinement, breeding of the muskrat has proved to be too difficult, too uncertain, and too expensive to make a study of its genetics easy. In spite of most careful attention, all of these mutants on hand have gradually been lost through disease, fighting during attempted matings, predation by hawks and owls, or accidents. It is quite evident that the working out of the genetics of the muskrat will necessarily be a slow process in contrast to that of such widely used laboratory animals as the house mouse, Norway rat, rabbit, and guinea pig.

Successful crosses involving the Maryland white mutation are reported in Table 1. The actual size of some of the litters as reported is not considered dependable, however, due to the difficulty and hazards of immediately examining and sexing the new-born, together with the post-natal mortality experienced. That the data given represent only a beginning is recognized by the writer. It is thought desirable to publish the results obtained to date, however, as muskrats are now at or near the low point of their cycle in this section and it becomes increasingly improbable that further stock can be secured in the near future.

Data given in Table 1 prove that the Maryland white is a recessive character and the symbol *w* is here proposed for this mutation. Both wild brown and black-and-tan are shown to be dominant over the new mutation.

Inheritance in the Maryland white.—Smoky-white female 66, trapped on McGraws Island marsh of the Refuge on February 27, 1938, by Curtis Insley, and weighing 2 pounds 8 ounces, was placed in a small breeding inclosure on March 17, 1939, with smoky-white male 59, trapped on Elliotts Island on February 26, 1939, by Fred Lyons. This pair failed to produce young in this small type of inclosure and was transferred to a large marsh inclosure 18 feet square

on June 14, 1939. Four maltese gray were born about June 10, 1940. This litter consisted of two females, one male, and one unsexed, and demonstrated that the mutant is a true recessive. Both parents were lost without further progeny.

Smoky-white female 84 was trapped alive by Elzey Keene on Horse Point marsh near Golden Hill, Maryland, on February 10, 1939, at which time she weighed 2¼ pounds and measured: body, 12¼ in.; tail, 9 in.; right hind foot, 3⅛ in. This female was placed in a marsh inclosure with black-and-tan male 31 on March 23, 1940, and produced a litter of four during the night of June 6. These were not disturbed, and on July 9 a second new-born litter of three or

TABLE 1.—*Crosses involving the Maryland white mutation*

PARENTS	NUMBER OF YOUNG	CHARACTER OF YOUNG
Maryland white ♂ 71 x black-and-tan ♀ 58....	4	brown
Smoky white ♀ 84 x black-and-tan ♂ 31.....	4	2 black-and-tan, 2 unrecorded
Smoky white ♀ 66 x smoky white ♂ 59.....	4	maltese gray
Smoky white ♀ 84 x black-and-tan ♂ 31.....	4	brown
Smoky white ♀ 84 x smoky white ♂ 111.....	5	maltese gray
Maryland white ♂ 71 x brown ♀ 60B (daughter of ♂ 71 and ♀ 58).....	3	2 brown, 1 maltese gray
Smoky white ♂ 111 x black-and-tan ♀ 90B (daughter of ♀ 84 and ♂ 31).....	1	light brown
Smoky white ♂ 129 x brown ♀ 18.....	2	brown
Brown ♀ 100C (daughter of brown ♂ 29 and black-and-tan ♀ 52) x brown ♂ 283B (son of ♀ 84 and ♂ 31).....	4	3 light brown, 1 black-and-tan
Brown ♀ 110B (daughter of brown ♂ 7 and brown ♀ 2) x brown ♂ 61B (son of ♂ 71 and ♀ 58).....	1	brown
Smoky white ♂ 201C (son of ♂ 71 and ♀ 60B) x brown ♀ 220C (daughter of ♂ 111 and black-and-tan ♀ 90B).....	3	1 brown, 2 unrecorded

four young was observed clinging to the teats of their mother as she plunged. A most careful examination on September 13 revealed that only one black-and-tan male and one black-and-tan female young, evidently from the first brood, had survived. At that time the mother appeared to be again pregnant. On September 17 she weighed 2 pounds 10 ounces and was so docile that the teats were palpated. The following morning no young had arrived, but an examination at 2 P. M. revealed parturition had just taken place. The mother weighed only 2 pounds 6 ounces at 8 A. M. on September 19, and the third litter of the season by this pair was found to consist of three brown males and one brown female (Pl. III).

Since this female produced both black-and-tan and brown young by a black-and-tan mate, her genetic formula clearly is $Aa^t\ ww$.

Female 84, in February, 1941, was found to weigh and measure exactly the same as she did when first trapped two years previously, but she had become entirely white except for the dark nose tip and some of the vibrissae. On March 9, 1941, this female was placed in a marsh inclosure with newly acquired smoky-white male 111. This resulted in a litter of one female and four male maltese gray, born on May 15, 1941. Female 84 was found dead on August 16, 1941, from bad slashes on the rump, inflicted by muskrats cutting through the wire netting from an adjoining inclosure.

Maryland white male 71 was obtained four days after being trapped by Al Garcia on Long Pond marsh near Robbins, Maryland, on February 28, 1940. At that time the animal weighed only 2 pounds 1 ounce, but was almost pure white and evidently was in its second year. He sired two litters before his death. Mated with black-and-tan female 58, a litter of four brown was produced on May 24, 1940, consisting of two males (61B and 63B), one female (60B), and one unsexed. The following season male 71 was then back-crossed to his brown daughter (60B) and this resulted in a litter of one brown female (200C), one brown male (203C), and one maltese gray (201C) on August 5, 1941. Since this male by a black-and-tan mate produced brown young he was clearly genetically brown. His brown daughter (60B) was *AAWw* in genetic formula.

A maltese gray (201C), when caught out of the large marsh breeding inclosure, weighed 8 ounces and measured: body, $7\frac{1}{16}$ in.; tail, $4\frac{3}{4}$ in.; right hind foot, $2\frac{1}{8}$ in. By March 26, 1942, 201C had become so light in color that he was termed a smoky-white, weighed 1 pound 15 ounces, and measured: body, $10\frac{1}{2}$ in.; tail, 7 in.; right hind foot, $2\frac{7}{8}$ in. On that date this male was transferred to another inclosure with brown female 220C (parents smoky-white male 111 x black-and-tan female 90B). From this mating at least three young were born during the night of July 17, 1942, but unfortunately only a single brown male survived when examined on August 5.

Male 201C was retained all winter in a marsh inclosure, and by March 4, 1943, he weighed 2 pounds $8\frac{1}{2}$ ounces, and measured: body, $11\frac{1}{2}$ in.; tail, $7\frac{1}{2}$ in.; right hind foot, $2\frac{7}{8}$ in. He had become entirely white except for dark vibrissae and a small area of dark hairs towards the tip of the nose, characteristic of the fully developed Maryland white. A slight amount of pigmentation was still present in the tail, but this had disappeared by the time of his death on June 23, 1943.

As this animal had been retained since birth in large marsh breeding inclosures 18 feet square that contained an abundance of the muskrat's favorite food plant, *Scirpus olneyi*, and was supplied in addition regularly with supplemental feeding of apples, dried ears of corn, and raw peanuts in the shell, the weights and measurements given are thought to represent as near normal growth development as can be approximated under such type of confinement.

Summary.—1. The two color phases commonly occurring in the Virginia or coastal muskrat, *Ondatra z. macrodon*, are called brown and black, respectively, by trappers. In genetic terms the brown type is a black agouti (*ABC*), owing its general reddish brown coloration to the strong development of the subapical band of the body hairs which in the agouti pattern is red or yellow. The so-

called black type is really a black-and-tan, since it has a modified agouti pattern in which the dorsum is black, but the sides show agouti type hairs banded with yellow, and the under surfaces are light as in the agouti type. Black-and-tan is true breeding and recessive to the brown type in crosses. Its genetic formula is a^tBC.

2. A uniformly black mutation, non-agouti black (aa) has been observed to occur in Virginia and North Carolina marshes. It is probably recessive to black-and-tan (a^t).

3. A recessive mutation in the black color factor (B) to brown (b) is probably represented in certain pelts described as "fawn," taken in the Chestertown, Maryland area. An alternative explanation would be to regard the fawn coat as due to a recessive mutation (e) in the factor for *extension* (E) of black pigment throughout the coat, as in fawn rabbits.

4. A true albino mutation, with pink eyes and pure white fur, is occasionally observed in at least three geographic subspecies of the muskrat. It is a recessive and so, undoubtedly, a true breeding mutation (c) of the color factor (C).

5. A new color mutation is described and named Maryland white, symbol w. Young individuals are maltese gray, but white underneath. The pigmentation decreases steadily as maturity is approached and fully adult animals are smoky-white or even practically all white except for a sooty nose spot, yet with eyes pigmented. This mutation is recessive to the fully colored type, whether brown or black-and-tan. It may be an allele of true albinism, in which case its symbol would be c^w. But this must remain uncertain until the critical mating, Maryland white x albino, can be secured. If that mating should produce young as light in color as Maryland whites or lighter, Maryland white would fall in the category of albino alleles. If the young should be full colored browns or black-and-tans, it would follow that Maryland white and albino are due to recessive mutation in two different genes. The occurrence of *light* browns recorded in Table 1 in matings expected to produce young heterozygous for Maryland white (Ww) indicates that the white gene may be incompletely recessive.

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DECOYING COYOTES AND DEER

By Seth B. Benson

Alcorn's article on decoying coyotes (this Journal, 27: 122–26, 1946) prompted me to try the method. I found that not only does it sometimes work for novices in coyote hunting, but also that it is highly effective in calling does at the time they have small fawns. I suggest that using a game call may become an efficient aid in making a doe census at this season. Also, but with less probability, it may be used effectively at other seasons for doe census work.

I first attempted to make a call, following the directions given by Alcorn, but with the instrument I fashioned I was unable to produce sounds that seemed likely to call up any animal. I then obtained one of Olt's "Adjustable Game Calls." With this I could produce a wide variety of sounds. I could even play tunes on it although not of musical quality. Because I had not heard a rabbit distress call for a long time, I was not certain that my imitation was of the proper quality. This difficulty was to be obviated by making arrangements to meet Alcorn in the field for a demonstration, but circumstances prevented.

I tried out the call while on a collecting trip to the Sweetwater Mountains, Mono County, California, in July, 1946. Most of my time was spent in hunting rodents, but I used the call often in places where I thought coyotes might be present. No coyotes were attracted to me, at least to my knowledge. The call was of interest to Steller jays, squirrels, and conies. Chickarees sometimes revealed their presence by answering the call, and on some occasions were decoyed. Marmots, golden-mantled ground squirrels, Belding ground squirrels, and chipmunks often responded by climbing to observation posts or by running to their burrows and sounding alarm notes. Even conies sometimes answered the call or emerged from talus to observe. In general, however, I had the impression that the call frightened these animals and caused them to seek cover.

It took several experiences to make me realize that the call was attractive to deer. Once, when calling at a cony slide, a yearling doe and young buck started up several hundred yards away and ran up a draw separated from me by a low ridge. A few minutes later I climbed the ridge and met the doe at the top at about ten yards distance. She snorted and fled into the adjacent forest of lodgepole pines. The doe had come in my direction, but at the time I thought her approach was accidental. A few days later I called from a place overlooking a sagebrush slope surrounded by lodgepole pines. A doe started up about 150 yards away and ran into the forest but reappeared to look at me when I repeated the call. Again I assumed that the call had no significance to the doe, except as a strange noise.

On July 26, 1946, in Swager Canyon at the south end of the Sweetwater Mountains, I called late in the afternoon from a forested hillside overlooking a meadow. By this time I had lost any confidence in calling up a coyote. Immediately after giving the call I heard a deer running in my direction from the hillside above me. A doe burst into view about twenty yards away, saw me, and ran away again. I called again and the doe returned. For about five minutes, in response to the calls, the doe ran about in a highly agitated fashion, coming

close when I called, but turning again in fear. The reason for her agitation was disclosed when I climbed the hill and flushed two fawns.

Two days later, in the same area, I called a doe from a thicket of mountain mahogany. This doe approached to within fifty yards, but quickly saw and scented me. The doe remained in the vicinity for several minutes before disappearing into the brush. It was evident that she was excited by the call, but not as much as the doe seen two days previously.

About an hour later I saw a deer entering a thicket of mountain mahogany on a nearly open slope high above me. I assumed she had seen me and was leaving the vicinity. I sat down on a rock on the bare ridge and gave the call. Immediately the doe came running out of the thicket at full speed down the rocky slope toward me. Somewhat taken by surprise, I watched her run the entire distance of about 300 yards, but called again when she passed me at a distance of about ten feet. She halted, stared at me, and then snorted and ran back up the slope. I assumed that she had a fawn in a mahogany thicket below me. By this time I was fully convinced that the call was highly attractive to does. In the several days previous to this occurrence I had seen no deer except the ones I had called, and tracks were few.

On several occasions in the following winter I tried out the call in Lake County, California, when I saw deer from the highway. Under these conditions the automobile was always in view of the deer. In every instance the deer was interested, but rather quickly turned to run away. I never had opportunity to call from a hidden location, so I do not know if the deer would have approached had I done so. I learned, however, that deer lying down would get up upon hearing the call which evidently startled them.

In July, 1947, I again visited Swager Canyon and, near the same place where I had called the last doe the year before, I called another to within seventy-five yards. I was in plain sight and up wind so that the doe was clearly aware of me. The doe often snorted and was obviously excited. She partly circled me, but kept her distance, and finally moved off up the opposite slope, stopping to stare and snort every time I called. At last she entered a patch of mountain mahogany about 300 yards away, but came out twice to look at me in response to calls before she disappeared for good.

A few minutes later I continued up the slope and called again. A coyote answered from about 200 yards away by howling and barking. It answered a second call, but not a third and fourth. Because the coyote was up wind, and because I had been calling the deer a few minutes before, I assumed the coyote had seen me and would not approach. After a few minutes I resumed walking in the direction from which the coyote had called, and called again after going about 100 yards. To my surprise a coyote came trotting out of the brush about twenty yards away and then stopped and looked in my direction, but, I believe, without seeing me, since it appeared to be curious but completely unsuspicious. When I fired at it with the shotgun it cried like a whipped dog but quickly died. It proved to be a young male coyote weighing 26.5 pounds. Its stomach contained sheep carrion.

On August 9, 1947, while on a trip to Rich Gulch, about fourteen miles west-

northwest of Quincy, Plumas County, California, I called often late in the afternoon. A gray squirrel (*Sciurus griseus*) and a red-tailed hawk answered the call, but did not approach. On the following day I called a doe to within twenty-five yards. I was seated on a stump in an opening among yellow pines and Douglas fir. I was in sight of the deer but down wind. The deer inspected me closely, but did not scent me. The doe was suspicious, but not greatly alarmed, and after about five minutes moved off into the forest. In a few minutes she was followed by another doe, a yearling buck, and a buck with large antlers. The bucks were made uneasy by the call, but did not approach, and quickly followed the trail taken by the first doe. It seemed apparent that the bucks were not attracted by the call, but were merely following the does.

The next morning at about 9:30 my call was answered by the barking of a coyote. The call was muffled by distance and did not include the usual howl. The coyote answered a second call, but not succeeding ones. Nothing appeared in the next five minutes and I walked up the trail with Mr. W. I. Follett, my companion. I soon called again from where the trail passed through a black oak thicket. We heard a rustling in the brush below and a coyote appeared about ten yards from me. The animal stopped and stared at me, but without apparent recognition of me as a source of danger. I killed it with a discharge from a shotgun.

This coyote proved to be a very old male, but in good physical condition and with a bulging stomach. The stomach contents were about one-third manzanita berries and the remainder freshly killed fawn, so fresh, indeed, that the fawn bladder still contained urine. The coyote had lost one upper canine, all the lower incisors, and a third upper molar. The lower canines were rounded off and barely protruded above the gums. The remaining teeth were much worn.

The element in the call of attraction for coyotes is unknown to me. As I gave it, the call began with a sharp ascending note somewhat resembling a coyote howl, followed by a series of descending notes which may, at least vaguely, resemble the distress cries of a rabbit. My guess is that the coyote element attracted the two coyotes, since they answered the calls, and because the second coyote could not have been particularly hungry. Both the coyotes appeared to be completely unsuspicious of any danger to them.

Deer, on the other hand, are excited by the distress element in the call, although it has scarcely any resemblance to the bleat of a fawn. The distress element is apparently recognized by the other species mentioned and also by domestic animals. I have startled range cattle and sheep into flight with the call, and even the most phlegmatic farm and dairy cattle are disturbed.

My results substantiate Alcorn's statement that coyotes of all ages can be decoyed. However, a large element of skill and knowledge of coyotes enters into successful use of the call. I succeeded in calling only two in many attempts, while Alcorn reports calling twenty-four coyotes and two lynx cats in forty-six attempts. I often used the call in places unsuitable for coyotes and rarely made any attempt at concealment. It is also quite probable that I did not make the

proper sound. On the other hand, I had success without the opportunity of witnessing a demonstration.

It appears to be probable that the call would be of much assistance in locating does in the fawning season, at least in relatively open country. It might also be effective in startling does into view at other seasons. It is less likely that the call would be of assistance in finding bucks.

Museum of Vertebrate Zoology, Berkeley, California. Received September 20, 1947.

NOTES ON THE RED SQUIRREL IN PITTSBURGH

By E. H. McClelland

There have been very few, if any, records of the red squirrel (*Tamiasciurus hudsonicus*) within the city limits of Pittsburgh, Pennsylvania, in recent times. These sketchy observations extend over a period of some twenty years, beginning in December, 1925. The observer has two city lots sloping down to a wooded ravine on the edge of Highland Park—a public park extending south from the Allegheny River.

During the winter of 1925–26 only a single red squirrel was seen (or only one at a time), rather emaciated and quite wild. The next summer one was seen occasionally, but during the winter of 1926–27 at least two occupied a flicker box (about thirty feet above the ground on an Ailanthus tree) into which they carried burlap taken from the covering of a bale of peat moss. This enterprise necessitated visiting a terrace at the rear of a garage near the residence of the observer. The squirrels fed there regularly on peanuts, butternuts, and black walnuts, and during the winter took the kernels from several ears of corn which were fastened to trees. Through the winter and spring, the only "direct communication" and close approach to the squirrels was by means of peanuts tied to the ends of strings dangling from windows and a porch above the terrace. When a squirrel "attacked" a peanut on a string, he invariably got it despite a person pulling on the other end.

At least one monograph, which should be authoritative, states that it is impossible to tame the mature red squirrel, but during the early summer of 1927 two adults were lured closer and closer by peanuts pitched to them, until eventually they would climb all over a person who was either sitting or standing up. In this, the squirrel showed no discrimination between those who fed him regularly and the casual visitor. Several chipmunks (*Tamias striatus*) had become equally tame. The squirrels regularly chased the chipmunks from the terrace, but never pursued them very far and never caught one.

Early in 1927, the red squirrels abandoned the flicker box which, in midsummer, was taken over by a swarm of honeybees. Occasionally a squirrel was seen in the Ailanthus tree and one day one of the tame squirrels was found on the ground with its head so swollen that the eyes were closed. It was unable, or

unwilling, to eat or drink. There was a suspicion that some nostalgic urge had taken it back to the old home where it had been stung.

Later generations of both squirrels and chipmunks were easily tamed, but eventually the taming was abandoned because of the fear that some visitor to the garden would be badly bitten—uninhibited children, and a few adults, being unimpressed when warned not to catch either animal.

For many years the young red squirrels did not appear in the garden until pretty well grown, but closer observation was made possible by the impact of politics. In 1938, the Work Projects Administration "cleaned up" the more accessible parts of the park ravine, cutting not only the blueberry bushes, the wild viburnum, and the last of the native rhododendron, but also the large dead and dying trees. Subsequently, for each of two consecutive years, a pair of squirrels raised a family in a box (like a flicker box, but weatherproofed by a corridor across the opening) on a post some sixty feet from the house. Because birds were taken care of elsewhere, the red squirrels were allowed to use a glass-walled feeding "station" a little lower than the kitchen windows and less than twenty feet away. This station, some seven feet above the level of the terrace, is on the top of a three-inch steel clothes post. The floor of the station is supported by a floor flange and a steel plate about six inches square, thus offering a considerable surface of metal. In trying to negotiate it, young squirrels sometimes fell, but they soon became quite adept. As an experimental barrier, a tin cylinder, 7 inches high and 4.5 inches in diameter, was slit and suspended around the supporting post, but the squirrels squeezed through with no difficulty. After testing it, this tin sleeve was removed. An effective barrier could of course have been installed, if desired.

With shelled corn, the red squirrel invariably ate only the "eye" or germ (a scarcity of food might reveal different habits), spent only a few seconds consuming a peanut, and handled sunflower seeds almost as rapidly as two to the second. Hard-shelled nuts were carried away, but never eaten in the station. Observed butternut shells were invariably gnawed on opposite sides exactly in the proper positions to extract the meat.

The red squirrels infrequently ate suet from sticks provided for winter birds (running up a short, vertical, three-fourths-inch galvanized pipe). They gnawed at, and carried away, small bones from ham and other cooked meats and, on one occasion, a squirrel killed a house sparrow by seizing it just as it lit on the perch of the station. He apparently ate part of it and, after a few seconds, carried it away. A chipmunk was once observed eating a mouse—some short-tailed species, probably a meadow vole. During the winter, the squirrels ate the bark of staghorn sumac (*Rhus hirta*), working on limbs an inch or less in diameter. Possibly because they had plenty of food elsewhere, they were never known to disturb the eggs of nesting birds, though there were many easily accessible nests of the robin, catbird, cardinal, mourning dove, wood thrush, and song sparrow—the last, both on the ground and in shrubbery.

Late in the fall of 1942, one red squirrel enlarged the seven-eighths-inch entrance to a wren house (suspended from a strap iron bracket) by gnawing an irregular

hole only one and one-half inches at the widest point, which let it enter. It carried in some shreds of bark from a blighted American chestnut, but was seen at the wren house for only one day afterwards.

The red squirrels occasionally, and the chipmunks regularly, devoured the seeds of the witch hazel and the chipmunks regularly stripped the berries from a *Cotoneaster*, apparently being interested chiefly in the seeds. The red squirrels regularly took all the nuts from a hickory (the "mockernut," *Hicoria alba*) about the time they were fully grown, and long before they ripened. The chipmunk was observed as high as forty feet in a large white oak and frequently climbed more than thirty feet for fruit of the wild cherry.

The olfactory sense of the chipmunk is apparently much superior to that of any of the other squirrels observed. Neither the gray (*Sciurus carolinensis*) nor the fox squirrel (*S. niger*) was able to go directly to a peanut thrown ten feet away on the lawn. The red squirrel did a little better, but generally ranged around rather than proceeding in a straight line, and seemed to depend on sight. The chipmunk, at a slight visual disadvantage by reason of its size, seemed to be guided entirely by scent; almost invariably, it would run or leap directly toward a peanut on the lawn, in short grass, or in a low ground cover like *Vinca minor*, and find it speedily.

During one summer, when the chipmunks were perfectly tame, a young nephew of the observer experimented with nutshells glued together, either empty or with some weight substituted in the form of paper wads, wooden blocks, or clay pellets, but, with chipmunks climbing over him by the hour, he never succeeded in getting one to take a shell without the edible content.

On two occasions, in late summer, a chipmunk dug out crocus bulbs three or four inches deep in hard, dry soil. With the foliage dead and shriveled, surely these were detected only by odor. The bulbs were not eaten, but were buried elsewhere, some of them more than six hundred feet away, under half an inch or so of soil. This traffic in bulbs becomes an expensive business for the gardener and fortunately, over many years, only the two "rogue" chipmunks appeared, several years apart. One departed this life via an air gun; the other via carbon disulphid after being caught in a small box trap. Twice during the campaign for the chipmunk, this trap caught a deer mouse which when released sat on the edge of the trap and seemed to be rather reluctant to leave.

For two consecutive days in 1930, a fine looking specimen of what was thought to be the fox squirrel was seen in a tree sixty feet or so from the house. In the spring of 1938, another stayed for a few days and was rather tame.

Prior to 1945, only an occasional gray squirrel was seen, and never for more than one day. Two different years, in the late summer, a single gray squirrel worked in an old pear tree, eating very little of the pears, apparently only to get at the seeds. In the summer of 1945, three gray squirrels appeared and from one to three stayed around regularly, but a gray squirrel in the city is no novelty and they were not encouraged.

The gray squirrels at first had a little trouble negotiating the approach to the station, but soon became skilful enough though never running up the steel post

with the speed of the red squirrel. The tin can barrier was effective in excluding them, but, after determining this, it was removed in the hope of observing the behavior of the red squirrel in relation to the gray. The two species were seldom seen in the yard at the same time, but on three occasions when a gray was in the station a red squirrel was observed on the terrace below. It never tried to enter, only once it ran part way up the supporting pipe. On two occasions a gray squirrel gnawed at the opening in a small bird house. Twice in May, 1946, a young gray squirrel climbed to the entrance of a wren house with young birds inside, but was chased away by the wrens.

There is a pool on the place (diverted from a water-supply system established by General Negley who settled here in 1778), and both species of squirrels occasionally drank at the overflow—the red squirrel pausing for only a second or so; the gray squirrel for more nearly a minute, but these observations were too limited to have any value.

At least two red squirrels were around during the summer and early fall of 1945, but none was seen after October 6.

Proximity to this wooded area in the park might be considered advantageous, but it has not been entirely so. Sudden disappearance of many of the squirrels was probably due to illegal shooting in the park—the same cause that decimated and eventually exterminated the bobwhite quail in the area where at one time as many as twenty-three regularly came to be fed. This shooting, of course, was illegal on several counts—within the city limits, in the public park, out of season, and by hunters not wearing the required display of evidence of a license.

The number of chipmunks varied greatly from year to year, and one factor may have been the weasel (*Mustela*). In December, 1925, a white weasel was seen. During the summer, a weasel was twice seen chasing a chipmunk though the latter apparently escaped—at least, when a weasel chased a chipmunk into a thicket of mountain laurel, a chipmunk emerged a few seconds later and was not pursued farther.

Even in this city lot, a competent observer of mammals might have found a number of things of interest. Several species of voles and moles were killed. A rather large opossum once appeared, and had hard going in a six-inch snow. In 1926–27, a woodchuck lived in the ravine and in 1945 a white woodchuck was shot on the adjoining property, where a muskrat was captured (and released) a few years earlier.

Technology Dept., Carnegie Library of Pittsburgh, Pittsburgh 13, Penna. *Received January 18, 1947.*

A NEW BAT, *OTOMOPS*, FROM PAPUA

By Barbara Lawrence

Although specimens of *Otomops* are infrequently collected, three species besides the type, *wroughtoni*, have been described and the genus appears to be widely distributed. Two African forms have been recognized; *wroughtoni* comes from southern India, and *formosus*, described by Chasen in 1939, is from western Java. The specimen at hand extends the known range as far as western Papua. It may be known as:

Otomops papuensis sp. nov.

Type.—Museum of Comparative Zoology no. 45769; adult female in alcohol, skull removed; collected at Vailala River, Western Papua. This river flows into the Gulf of Papua about fifteen miles west of Kerema.

Distribution.—Known from the type locality only.

Diagnosis.—Distinctly smaller than the other members of the genus with no whitish patch across the shoulders and premaxillae not fused.

External characters.—As the specimen was preserved in alcohol an exact account of its color would be valueless; the pattern of lighter and darker areas can be determined more accurately. The general color above is rich reddish brown, the hairs having dark tips and paler bases. The darkest areas are on the crown and the lower back, where the bases of the hairs are only slightly paler than the tips, and a narrow strip along the wing membranes on each side where the shorter, darker hairs lack pale bases. The characteristic pale mantle found in other members of the genus is only suggested by a distinct band across the shoulders of longer very conspicuously pale-based hairs, while the hairs on the forehead between the ears are similarly pale-based. There is no white on the inner bases of the ears. The ventral surface, particularly on the throat, is paler than the dorsal surface. The fur patches on the membranes and on the anterior, external base of the ear are as described for *wroughtoni* with an additional patch in *papuensis* between the base of the fourth and fifth metacarpals. The large, rounded ears, as in *wroughtoni*, have no antitragus. The tragus is represented by a minute lump, scarcely large enough to be visible to the naked eye. The extra lobe on the inner side of the conch mentioned by Thomas and figured by Chubb for the South African form, *icarus*, is present though less well developed than in the latter. The rounded anterior margin of the ear has fifteen or sixteen horny excrescences. The ears are broadly connected by a band which bulges forward over the nose to form a shallow pocket, opening posteriorly. The connecting band is hairy, but there is a small naked patch of skin immediately posterior to it on the forehead between the ears. The upper lip lacks the close wrinkling found in related genera, instead its fullness on each side is drawn into two ill-defined folds. No stiffened spoon-hairs are found on lips or chin. The unusual development of the strongly projecting muzzle pad, surrounded by horny excrescences, gives the head a tube-nosed appearance in profile. Both the unwrinkled lips and projecting muzzle pad are as shown in Chubb's figures of *icarus*.

Cranial characters.—Except for its small size and the wide separation of the premaxillaries, the skull differs little from Thomas' description of *wroughtoni*. The shape of the skull, the large postorbital plate on the zygomatic arch, the suggestion of a sagittal crest, the inflated anterior projection of the tympanics reaching as far as the pterygoids, and the length of the incisors are all as shown in photographs of the skull of the large Indian form. Although the enormous development of the basisphenoid pits with sharply overhanging edges does not show in these pictures, the less-developed but still conspicuous pits on the basioccipital do. The posterior edge of the palate is level with about the middle of M^3. The slightly-developed occipital crest does not extend transversely across the back of the

skull, but is projected forward in a V which meets the sagittal crest at the highest point of the cranium and leaves the back of the skull smoothly rounded.

Remarks.—The most striking characteristic of the *Nyctinomus-Chaerephon-Mops* type of bat seems to be a great variability. Dobson (1874: 144) first used *Chaerephon* for *johorensis* in which the ears are united by two connecting bands of skin. Miller (1907: 245) expanded the genus to include all of the group in which the premaxillaries are complete. Thomas, when he described *wroughtoni*, pointed out that, although the general appearance of its skull was that of *Nyctinomus*, the structure of the premaxillaries was that of *Mops* (= *Chaerephon* of Miller) and concluded that the structure of the premaxillaries was a less important generic character than the degree of development of the fourth commissure of M^3. *Mops* thus was made to include species with or without united premaxillaries, but with this commissure obsolescent. The species having this commissure developed to extend inward about as far as the anterior angle were put into three genera, *Nyctinomus*, *Chaerephon*, and *Otomops*. *Nyctinomus* was then distinguished from the other two on the basis of the separation of the premaxillaries. The discovery of an otherwise typical *Otomops* with the premaxillary structure of *Nyctinomus* again points up the unreliability of this character. Further, Hill and Carter (1941: 53), finding that "the difference between the V-pattern of M^3 in *Mops* and the N-pattern characteristic of *Tadarida* [= *Nyctinomus* + *Tadarida*] . . . is partly bridged in *Mops angolensis*, and the characters separating *Tadarida* from *Chaerephon* are extremely variable," come to the conclusion that *Mops* and *Chaerephon* are only subgenerically distinct from *Tadarida*. Certainly these three are far more closely related than *Otomops* is to any of them, and the characters of basisphenoid, tympanics, and zygomatic arch are more diagnostic than are those of M^3 and the premaxillaries.

Measurements.—Taken by author and given in millimeters. As the specimen had hardened considerably, the total length in a fresh individual would probably be somewhat greater. External: total length, 97; tail, 30; hind foot (*c.u.*), 10.6; hind foot and tibia, 23.5; ear, 22.2; forearm, 49.2. Cranial: greatest length from front of incisors to back of brain case, 20.2; basal length, 16.2; length from posterior edge of nasal aperture to highest point of cranium, 14.8; greatest width of brain case, 9.5; width across roots of zygomatic arch, 10.6; mastoid width, 10.4; distance from bottom of bulla to highest point of brain case, 9.9; height of zygomatic plate, 2.2; length of upper tooth row (I–M^3), 8.5; length of lower tooth row (C–M_3), 7.7.

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Museum of Comparative Zoology, Cambridge, Mass. Received June 4, 1948.

GENERAL NOTES

THE STATUS OF THE SEMINOLE BAT, *LASIURUS SEMINOLUS* (RHOADS)

Since the description (Rhoads, Acad. Nat. Sci. Philadelphia, March, 1895: 32) of the Seminole bat as a subspecies of *Lasiurus borealis* (Müller), some authors have considered it a distinct species while others continued to treat it as a subspecies. Miller (N. Amer. Fauna no. 13: 109, 1897) stated that "*Lasiurus borealis seminolus* appears to be a well marked subspecies confined to the Austroriparian fauna. . . . No intermediates between *seminolus* and true *borealis* has [sic] yet come to light, but the perfect agreement of the two forms in all charaters [sic] except color makes me unwilling to recognize them as species. The possibility that *seminolus* and true *borealis* are dichromatic phases of one species lacks weight on account of the total absence of intermediate specimens, and also from the fact that both forms have not yet been found breeding at any one locality."

Howell (N. Amer. Fauna no. 45: 26–27, 1921) treated it as a full species. In discussing specimens taken in northern Alabama (*ibid.*) he stated, "These show no evidence of intergradation with *borealis*, and the material at present available indicates that this form is a distinct species."

Miller (U. S. Nat. Mus., Bull. 128: 78, 1924), however, continued to consider it a subspecies of *Lasiurus borealis*. Harper (Proc. Boston Soc. Nat. Hist., 38: 274–7, 1927) took immature specimens of both the red bat and the Seminole bat in the Okefinokee Swamp and concluded that (*loc. cit.*: 277) "Both forms evidently breed in the region, and there is no intergradation in color between the two. Therefore I quite agree with Howell (1921, p. 27) in considering them neither geographical races nor mere color phases of a single species." Most subsequent authors have followed Harper in considering these forms specifically distinct. Dr. H. B. Sherman has taken pregnant females of both species in the vicinity of Gainesville, Florida.

Since the taxonomic status of *Lasiurus seminolus* is still somewhat uncertain, it seems well to record the following observations: At Auburn, Lee County, Alabama, these forms are equally abundant during the spring and summer. A hill on the Alabama Polytechnic Institute Experiment Station provided an excellent location for collecting and a number of bats were shot there from 1936–41. This grassy, low hill of approximately ten acres contains a few medium-size deciduous trees. The hill overlooks a branch on the opposite side of which are several small cultivated fields. The bats regularly fed along the stream course, over the experimental fields, and among the openings between the trees on the hill.

Red and Seminole bats began feeding early in the evening and it was frequently possible to separate the individual species as they wheeled and darted among the trees. No segregation of forms could be noted during these feeding periods. Shortly after the red and Seminole bats appeared, evening bats (*Nycticeius humeralis*) began to fly in the area. Just before it became too dark for accurate shooting, big brown bats (*Eptesicus f. fuscus*) and pipistrelles (*Pipistrellus s. subflavus*) took wing.

On May 9, 1938, two bats were shot as they fed in an opening on the hillside. Both were over the area at the same time and were collected almost simultaneously. One proved to be a pregnant *Lasiurus borealis borealis* containing two embryos and the other was a gravid *Lasiurus seminolus* also bearing twins. Both sets of embryos appeared to be in approximately the same developmental stage. On May 12, 1938, five female bats were collected as they flew over the open area. One was a red bat containing four embryos, one was a Seminole bat with three foeti, and two were evening bats (one carrying two embryos and the other four). A non-pregnant female *Pipistrellus subflavus subflavus* was the fifth specimen.

Both red and Seminole bats have been observed feeding and flying simultaneously in the same area on numerous occasions throughout Alabama. This is especially true in the spring and summer. The preceding instances, however, were the only ones in which pregnant females were taken in the same area at the same time.

Fall and winter observations in Alabama indicate that the *Lasiurus seminolus* population

in the northern part of its breeding range makes a definite seasonal shift southward. In the vicinity of Auburn, a few red and evening bats are active on warm days throughout the winter. Numerous observations and limited collecting have so far failed to demonstrate any active Seminole bats after cold weather has begun. More intensive collecting may produce an occasional wintering *seminolus* in northern Alabama, but our observations indicate such an occurrence would be accidental.

It should be pointed out that the influx of migratory *Lasiurus borealis borealis* could produce the illusion of a decrease in the wintering *Lasiurus seminolus* population or that *seminolus* remains in hibernation throughout its northern range. Neither seem likely since observations made in Alabama's coastal areas in the winter indicate that *Lasiurus seminolus* feed regularly during the warmer days and an appreciable per cent of bats active in the coastal region at this time are of this species. Limited observations indicate that the relative proportion of active wintering Seminole to red bats decreases as we leave the coast and go northward. North of the "fall line," wintering Seminole bats seem to be extremely rare or absent entirely.

Since the Seminole bat and red bat commonly feed and occupy the same general habitats in their overlapping ranges, and since pregnant females of the two kinds have been taken in the same area at the same time, I am of the opinion that *Lasiurus borealis borealis* (Müller) and *Lasiurus seminolus* (Rhoads) are distinct species. The absence, so far, of any dichromatic litters as well as the southward shift of the northern Seminole populations in the winter seem to preclude these animals being color phases of the same species.—Frederick S. Barkalow, Jr., *North Carolina State College of Agriculture and Engineering, Raleigh, N. C.* *Received June 7, 1948.*

A SUMMER AGGREGATION OF LUMP-NOSED BATS AT LAKE PEND OREILLE, IDAHO

On July 30, 1947, while on a collecting trip I found a colony of the lump-nosed bat (*Corynorhinus rafinesquii intermedius*) in an abandoned cabin on Derr Island, at the mouth of the Clark Fork River, Lake Pend Oreille, Idaho. Approximately one hundred of these bats were hanging from the rafters. No young were observed.

The accumulation of dung in the attic was about two inches deep at one end, suggesting that the bats tended to cluster there. When I first disturbed them, they were loosely clustered above this area.

Five specimens were collected and deposited in the Charles R. Conner Museum at the State College of Washington.

On August 8, 1947, a female of this species, with one young clinging to it, was found in an abandoned mine building near Lakeview on Lake Pend Oreille, Idaho. The young was about half the size of the female and much darker in color. No other bats of this species were found on this trip.

In "The Recent Mammals of Idaho," Davis (1939: 124) gives the range of the race *intermedius* as "probably . . . restricted to the southern part of the state." These records from Bonner County indicate a more extended range in Idaho.—Gardiner F. Jones, *Pullman, Washington.* *Received June 17, 1948.*

LITTLE BROWN BATS COPULATING IN WINTER

On January 3, 1948, five members of the Pittsburgh Grotto, National Speleological Society, visited "Coon" Cave at the head of Bear Pond Hollow on Chestnut Ridge, Westmoreland County, Pennsylvania. The cave is at an altitude of approximately 2400 feet, small, and formed by solution in the silicious Loyalhanna Limestone, leaving the exposed surface of the wall and floor sandy. The air temperature inside was 49 degrees F., 19 degrees above the outside temperature. The walls were wet, and a small stream, the temperature of which was 46 degrees F., flowed actively from the cave.

Approximately 200 *Myotis* (little brown bat) and one *Pipistrellus subflavus* were noted.

The *Pipistrellus* and the majority of the *Myotis* were covered with beads of moisture—lethargic and hibernating. Ahead in the darkness, however, others could be heard squeaking before they were disturbed. After they were disturbed some took flight immediately, while others, although they remained hanging, were breathing heavily. Their fur was wet and muddy. Two pairs of *Myotis lucifugus* were found in active copulation. One pair was collected and is now in the Carnegie Museum, Pittsburgh, Pennsylvania. Owing to the inaccessibility of the cave and the undisturbed crusted snow at its mouth, it seems very unlikely that these bats had been disturbed previously by human visitors.

Two days after the bats were collected a drop of liquid squeezed from the vagina of the female held a heavy concentration of living spermatozoa. Spermatozoa were also obtained from the testes of the male, and permanent slides of them were made at that time.

Although it is known that little brown bats mate either in the spring or in the fall, and that spermatozoa from a fall mating may remain throughout the winter in the uterus of the female—actual fertilization taking place in the spring (Asdell, S. H., Comstock Publ. Co., p. 85, 1946)—no mention could be found of mating taking place during the winter.—JOHN E. GUILDAY, *Carnegie Museum, Pittsburgh, Penna.* *Pennsylvania Pittman-Robertson Project 20-R. Received June 30, 1948.*

BREEDING COLONIES OF BATS, *PIPISTRELLUS HESPERUS* AND *MYOTIS SUBULATUS MELANORHINUS*

Bats of the species *Pipistrellus hesperus* and *Myotis subulatus* are commonly collected in many western semi-arid regions. Most specimens are obtained by shooting at twilight. They are difficult to find, however, in their daytime retreats. The few *Pipistrellus hesperus* that have been found were taken, nearly always singly, from cracks in cliffs, under loose rocks, and from crevices in mine tunnels (Stager, Jour. Mamm., 24: 266, 1943). They have also been found night-roosting in an adobe building. There is little published information on the roosting places of *Myotis subulatus melanorhinus*. Philip Krutzsch has found them in San Diego County, California, in crevices in rocks, in tunnels either in cracks or hanging in the open, in the window frame of an adobe shack, and night-roosting in stucco buildings. They are usually considered to be rather solitary in habits. Since neither of these bats makes extensive use of man-made structures as daytime retreats, little is known of their breeding habits. Recently, however, we have seen that the females with young show the same colonial tendency which has been observed in many other bats.

We had an exceptional opportunity to observe *Pipistrellus hesperus* where these bats were living on a man-made structure. William B. Richardson discovered the bats at his home five miles east-southeast of Porterville, Tulare County, California. Between the adobe wall of the house and the open wooden shutters, there is a space about an inch wide. In this space, adults and young of both sexes were found clinging to either the adobe wall or the shutter. On July 13, 1946, we found a dozen bats behind one shutter in the evening and about eight behind another the next morning. Of six bats collected, three were immatures, two were adult females, and one was an adult male. On February 2, 1947, we could find no bats. On June 15, 1947, behind one shutter were three lactating females, each with two non-volant young, and one adult male; behind another was one adult male; behind a third was one bat which escaped. On September 9, 1947, we found three males and one female, each behind a separate shutter, and two bats which escaped from behind another.

On May 26, 1947, Eben McMillan found a colony of *Myotis subulatus* under the wallpaper in a room of an abandoned wooden house one mile southwest of Cholame in San Luis Obispo County, California. He collected four, all females, one with a young attached. On May 28 another gave birth to a dead young 20 millimeters long. On June 16, we visited the house and, in a different room, found a close group of bats between the loose wallpaper and the wooden wall, about five feet from the floor. We caught nineteen adult females, and five male and eleven female non-volant young. At least two adults escaped through a crack

to the outside.—Carl B. Koford and Mary R. Koford, *Museum of Vertebrate Zoology, University of California, Berkeley 4, California.* *Received March 2, 1948.*

POLYDACTYLY IN THE MEXICAN FREE-TAILED BAT

On March 24, 1947, we collected a specimen of the Mexican free-tailed bat, *Tadarida mexicana*, which had six digits on each of the four extremities. It was found with seven normal individuals behind the window shutters of a house in Berkeley, California. We have since collected fourteen other normal ones from the same place. The abnormal bat was a male, and now is specimen number 108893 in the Museum of Vertebrate Zoology.

The extra fingers are about one inch long. They project forward from the wrist entirely free from the wing membranes, but with slight webs of their own. Examination of the skeleton shows that they originate medial to the thumbs and without any abnormality or increase in the carpals. They have four segments, the three proximal ones bony and the fourth cartilaginous. They were apparently not subject to any voluntary control. The six toes on each foot were all functional, with a fringe on the outer toes of each foot, so that we could not pick out the extra one. Examination of the skeleton shows ossification between the second and third toes, as if the second toe might have split into two. The bat seemed perfectly normal in all other respects.—Mary R. Koford and Philip H. Krutzsch, *Museum of Vertebrate Zoology, Berkeley, California.* *Received March 29, 1948.*

LONGEVITY OF THE BIG BROWN BAT

Lafleche Cave, Gatineau County, Quebec, provides winter shelter for colonies of several species of hibernating bats. The most numerous is the big brown bat (*Eptesicus fuscus fuscus*). This cave has been visited regularly by naturalists for the past several winters. The bats were first banded by Harold B. Hitchcock in 1939.

When the cave was examined on February 7, 1948, sixteen big brown bats were banded with Fish and Wildlife Service bird bands and ten recoveries were made, including two males which had been banded by Hitchcock on November 25, 1939. These bats, which are eight years and three months old, are believed to constitute a record of longevity for the species. Many of the bands had been chewed and were practically illegible.—A. W. F. Banfield, *Dominion Wildlife Service, Ottawa, Ontario.* *Received March 25, 1948.*

CORYNORHINUS MACROTIS, BIG-EARED BAT, IN WEST VIRGINIA

The occurrence of *Corynorhinus macrotis* LeConte in West Virginia has been established by W. C. Legg and W. H. Davis. On November 22, 1947, they took two bats of this species from Collison Cave, Nicholas County (38° 11′ N, 80° 53′ W; 1750 feet alt.). The bats were hanging close together and were the only ones observed. Both were given to the writer and bear his numbers 577–78. On December 7, 1947, Mr. Legg collected, and sent to me, a third specimen—again the only bat observed—from the same cave. This specimen (no. 585), a female, weighed 8.9 grams and measured 100–48–12–34 mm. One of the bats, no. 578, has been deposited in the Carnegie Museum, Pittsburgh; its identification was verified by J. Kenneth Doutt.

Previously, *C. macrotis* has been reported as far north as the Dismal Swamp in Virginia (Miller, 1897, N. Amer. Fauna, 13: 52). Miller's (*ibid.*) Bowling Green, Kentucky, record was referred to *C. rafinesquii* by Allen (Mus. Comp. Zool., Bull. 60: 341, 1916), and Allen's (*op. cit.*: 351) Mitchell, Indiana, specimen was listed as *C. rafinesquii* by Lyon (Amer. Mid. Nat., 17: 87, 1936). Hence, and according to Hamilton's map (Mammals of eastern U. S.: 104, 1943), the West Virginia collection may stand as the northernmost record.—W. Gene Frum, *640 N. High Street, Morgantown, West Virginia.* *Received March 6, 1948.*

THE MEXICAN FREE-TAILED BAT IN TARRANT COUNTY, TEXAS

On March 5, 1947, two Mexican free-tailed bats (*Tadarida mexicana*) were collected in an unoccupied farm house three miles east of Roanoke, in northern Tarrant County,

Texas. As the locality is a new one for these bats in the State and, as a rather early appearance date is indicated, the capture of these two specimens seems worth recording. The house had been entered fairly early in the morning; shortly thereafter one of the bats was noted flying rather sluggishly about the vacant rooms and was easily captured by hand. Some few minutes later the second appeared in the same manner and was also easily secured. The house was then diligently searched, but no indication of additional specimens was discovered.

It is possible that the bats had spent their winter's hibernation in some crack or cranny of the walls and that their awakening had been hastened by our intrusion; it is also possible that they had sought the place for temporary daytime seclusion. The two proved to be a pair; they showed no evidence of breeding and their stomachs were empty.—F. W. MILLER, *The Dallas Museum of Natural History, Dallas, Texas. Received March 2, 1948.*

EARLY BREEDING OF THE TEXAS BEAVER

Through the co-operation of the Texas Game, Fish, and Oyster Commission, the Dallas Museum of Natural History, during the month of February, 1947, obtained, in the flesh, three specimens of the Texas beaver (*Castor canadensis texensis*) from Mr. John T. McInnis, a rancher of Spicewood, Texas. Mr. McInnis had been licensed by the Commission to trap the beaver because they were inflicting damage on his pecan orchard and other ranch property lying along one of the tributary creeks of the Colorado River near the post office of Spicewood in extreme southeastern Burnett County, Texas.

Of the three trapped, two were pregnant females. The first of the females, taken on February 19, 1947, was found to contain two nearly full-term embryos and parturition would likely have occurred in the succeeding twenty-four hours. These two kits were preserved as specimens. Each weighed one and one-fourth pounds; they measured, respectively, 264 mm. and 271 mm. in total length. The second female, taken February 23, 1947, contained a single embryo of similarly advanced development, but as it was necessary to disembowel this female in the field, the kit was not saved. In both cases, on the hind feet of the kits, the split "grooming nails" of the inner toes were perfectly formed and apparently would have been functional at birth.—F. W. MILLER, *The Dallas Museum of Natural History, Dallas, Texas. Received March 2, 1948.*

YOUNG BEAVERS

Two litters of beaver, born in late summer in the State of Washington, adds some information on reproduction. These kits were born in holding pens (4 x 6 feet) used to hold beaver during the operation of live-trapping and transplanting.

Two kits were borne July 25, 1947, by a female trapped from Otter Lake, King County. Both kits were furred and had their eyes partly open on the first day. By the second day their eyes were well opened. Their incisors were about ⅛ inch long at birth. One kit was noticeably darker than the other. One died when three days old, the other when four days old. Their weights and measurements at birth were, respectively, weight, 14 oz., 13 oz.; hind foot, 2⅝ in., 2½ in.; tail, 2¾ x 1⅛ in., 2¾ x 1⅛ in.; total length, 11¾ in., 11⅝ in.

On the second day, while feed was being placed in the pen, the mother retreated to the lower end of the pen which was in about five inches of water. One of the kits slowly followed, but as it started out into the water the mother uttered a low warning cry and the kit turned quickly and retreated to the dry end of the pen.

Although most beaver eat well while in these holding pens, the mother of these kits fed very little after the young were born.

A second female, trapped from the Colville River in Stevens County, gave birth to one young on September 11, 1947. This kit apparently was killed soon after birth by other beaver in the same holding pen. It was partly mutilated when first observed.

The mother of the first litter was a small young animal; she was trapped with two other

females. The mother of the September 11 kit was a large three-legged beaver. One foot apparently had been lost in a steel trap. She was in a very thin condition.

There seemed to be no evidence that these were second litters of the season. Possibly a shortage of males, in one case, and the thin condition of the three-legged beaver would account for these late litters.—STANLEY E. GUENTHER, *Dept. of Game, 515 Smith Tower, Seattle 4, Washington.* *Received March 29, 1948.*

THE GIANT ARMADILLO, *HOLMESINA SEPTENTRIONALIS* (LEIDY), NEW TO THE PLEISTOCENE OF OKLAHOMA

A single scute of the carapace of *Holmesina septentrionalis* (Leidy), Museum of the University of Oklahoma, no. 41-30-S1, was collected at Hydro, Caddo County, Oklahoma, in the summer of 1947, by William E. Salter of the United States Geological Survey. He presented it to J. Willis Stovall of the University of Oklahoma.

The specimen was found in high-level, reworked, river gravel at about 100 feet above the level of the bed of the Canadian River. Stovall (Jour. Paleo., 11: 450–55, 1937) reported, from this locality, fragmentary remains of the following: proboscideans, equids, *Bison*, and *Euceratherium bizzelli* Stovall. Based upon the specimen of *Euceratherium*, he made the following comment regarding the age of the deposit: "The geological age of the animal is unquestionably Pleistocene, and judging by the lack of replacement of the bone, probably late Pleistocene." *Holmesina* has not been previously reported except from Florida and Texas, and this is apparently the most northerly record of its occurrence.

We are grateful to Dr. G. G. Simpson for permission to study the remains of *Holmesina* in the American Museum of Natural History. No scute was found in the American Museum collection that is a duplicate of the Oklahoma specimen, though there are no characters that distinguish the scute from those of *Holmesina septentrionalis* from Florida. We are unable to tell whether the scute belonged to the anterior or posterior part of the dorsal shield which in these forms was rigid. It is five-sided, as a truncated diamond would be, and is properly defined as an irregular pentagon with the four longest sides being slightly unequal. The fifth side is perpendicular to the long axis which measures 41.6 mm. The short axis is 33.3 mm. Its thickness is 8.1 mm. The surface is externally sculptured with many tiny pits. A slight ridge, set back 2.8 mm. from the margin of the scute, goes completely around the bone. In the center of the depressed area bordered by the ridge is a small teardrop elevation which is pendant to the short or truncated side. Ankylosis along the sutures is incomplete.—J. WILLIS STOVALL AND CLAUDE W. HIBBARD, *Museum of the University of Oklahoma and University of Michigan.* *Received March 16, 1948.*

A SECOND RECORD FOR CUVIER'S WHALE FROM THE PACIFIC COAST OF UNITED STATES

In a letter from Mr. S. T. Kelsey, Jr., of Ferndale, California, dated March 27, 1947, the writer was informed of the presence of a partial skeleton of a whale that had washed ashore about a year previous on the nearby coast of Humboldt County close to Big Flat. The letter, which was accompanied by one of the two teeth found in the lower jaw, contained such an accurate description of the skeletal remains that there seemed little doubt but that they belonged to some sort of beaked whale. On further correspondence Mr. Kelsey agreed to secure part of the skeleton. This entailed a ten hour trip with pack horses as the section of beach where the whale had washed up was inaccessible by road.

The skeletal parts that finally reached the California Academy of Sciences in San Francisco consisted of the skull, mandibles, hyoid bones, two sternebrae, the first four cervical vertebrae (fused), one lumbar vertebra, eight caudal vertebrae, and two ribs. Upon examination, the partial skeleton saved proved to be that of Cuvier's whale (*Ziphius cavirostris*) and is now number 9353 in the Academy's mammal collection. The greatest length of the skull measured 905 mm.

So far as known, this constitutes the second record for this species from the Pacific coast of United States. A previous instance of occurrence was published by Hubbs (Jour.

Mamm., 27: 242–55, 1946).—ROBERT T. ORR, *California Academy of Sciences, San Francisco, California. Received March 26, 1948.*

A SCHOOL OF WHALES, *KOGIA*?

The recent note in this journal (vol. 29, no. 1: 76–77, Feb., 1948) and G. M. Allen's paper (Field Mus. Nat. Hist., Zoöl. Ser., vol. 27: 17–36, 1941), which is cited therein, provide no indication to date of gregariousness in this small whale (*Kogia*). In fact Allen (*ibid.*: 23) stated that apparently it is a non-social animal, although (*ibid.*: 25–26) a calf may follow its mother for about a year. Thomas Barbour (NATURALIST AT LARGE, Little, Brown, and Co., 1943: 247–248), in mentioning three Virginia specimens that had been discussed by Allen (1941: 22), went a step farther than the latter in stating that the reason the specimens were cut, probably by propeller blades, was because these whales had a way of following ships. This would seem to indicate a social trait. These were two adults in different years, one with a calf nearby.

In Frank T. Bullen's THE CRUISE OF THE "CACHALOT" ROUND THE WORLD AFTER SPERM-WHALES—first published in London in 1898 by Smith, Elder, and Co., and of which there have been several editions and many impressions and reprintings—there is one reference to *Kogia*. Although there are errors in the book, an example being the statement that five *Kogia* yielded seven barrels of oil each, there are many interesting and accurate natural history observations. It apparently was prepared for publication years after the voyage by enlarging from memory notes made on the trip. The voyage was begun in 1875, but events cannot be dated from reading the book. The following paragraph from page 125 of the 1921 edition (London: John Murray) refers to an incident near the Aldabra islands, north of Madagascar:

"There was a little obliquity about the direction of the spout that made me hopeful, for the cachalot alone sends his spout diagonally upward, all the others spout vertically. It was but a school of kogia, or 'short-headed' cachalots; but as we secured five of them, averaging seven barrels each, with scarcely any trouble, I felt quite pleased with myself. We had quite an exciting bit of sport with them, they were so lively; but as for danger—well, they only seemed like big 'black fish' to us now, and we quite enjoyed the fun. They were, in all respects, miniature sperm whales, except that the head was much shorter and smaller in proportion to the body than their big relations."—RALPH S. PALMER, *Dept. of Zoölogy, Vassar College, Poughkeepsie, N. Y. Received June 1, 1948.*

THE TYPE LOCALITY OF THE BONTBOK, *DAMALISCUS PYGARGUS* (PALLAS)

In his paper entitled "The Nomenclature and Type Localities of Certain Old World Mammals" (Journ. Mamm., 21: 328, 1940), Dr. F. Harper makes the following statement: "Apparently the first mention of a definite locality is by Masson (Philos. Trans., Vol. 66, pt. 1, p. 287, 1776), who met with the bontebok at the 'Caffer Kuyl's Rivier', between Swellendam and Mossel Bay. This is the modern Kaffir Kuils River, in the Riversdale district, Cape Province, and it is here suggested as the restricted type locality."

There is, however, a very much earlier reference in the journal of Ensign Isaq Schrijver under the date 11 January, 1689, *vide* Journals of the Expeditions of the Honourable Ensign Olof Bergh (1682 and 1683) and the Ensign Isaq Schrijver (1689), transcribed and translated into english and edited with a foreword and footnotes by Dr. E. E. Mossop (Van Riebeeck Soc., publ. no. 12: 211, Cape Town, 1931). The relative extract from Schrijver's journal reads as follows: "Tuesday 11 dto [i.e. 11 January, 1689]. We left the said Swarte Revier before sunrise and passed good land as before. On the way we saw more than 1,000 'bonte harte bokken' running. Our course was directly East. To the North we had a high mountain range [i.e. the Sonderend Mountain Range, E. E. Mossop], its kloofs everywhere covered with dense and extensive woods. About 11 o'clock in the forenoon we arrived at the revier Sonder End, where we made our resting place at the Calabas Coral."

Dr. Massop states that Schrijver's "Calabas Coral" was at or near the present Nethercourt (Ziekenhuis).

It is clear from this account that Schrijver met with *D. pygargus* in large troops between the Swart River and the Sonderend River (modern spellings). He probably met with them soon after leaving the Swart River not far from the present town of Caledon. As this is a definite record and predates that of Masson by 87 years, it is suggested that the Swart River be designated the type locality of *D. pygargus*.—R. BIGALKE, *National Zoölogical Gardens, Pretoria, South Africa. Received March 16, 1948.*

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(Conducted by Gerrit S. Miller, Jr., Remington Kellogg, and Emma M. Charters)

[Reprints of this section may be purchased from the Corresponding Secretary]

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KRETZOI, M. Mammonteus Hungaricus, ein neues Waldmammut aus Ungarn. Földtani Közlöny, vol. 71, nos. 7–12, pp. 343–345. 1941. (New: *Mammonteus hungaricus*)

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KRETZOI, M. Präokkupierte Namen im Säugetiersystem. Földtani Közlöny, vol. 71, nos. 7–12, pp. 349–350, 1941. (New: *Pliotragus* for *Antilope ardea* Depéret ex Croizet, *Epicricetodon* for *Cricetulus grangeri* Young, *Pachychoerops* for *Anthracotherium bumbachense* Stehlin, *Opsolagus* for *Lagomys oeningensis* Meyer, *Nipponicervus* for *Cervus praenipponicus* Shikama; *Ctenocerus* for *Pliocervus* Hilzheimer)

KRETZOI, M. Seehund-Reste aus dem Sarmat von Érd bei Budapest. Földtani Közlöny, vol. 71, nos. 7–12, pp. 350–356, figs. 4. 1941. (New: *Praepusa*, *P. pannonica*, *Monachopsis* for *Phoca pontica*, *Pontophoca*, *P. simionescui*)

KRETZOI, M. Spelaeus-fauna aus dem Mecsek-Gebirge ohne Höhlenbären. Földtani Közlöny, vol. 72, p. 1. 1942.

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Roman et Joleaud, *Cadurcodon* for *Cadurcotherium ardynense* Osborn, *Sharamynodon* for *Amynodon mongoliensis* Osborn, *Amynodontinae*, *Cadurcotheriinae*, *Metamynodontinae*, *Paramynodontinae*)

KRETZOI, M. A Tigrisgörény, Görény és Nyérc a Magyar Pleisztocénben. Földtani Közlöny, vol. 72, pp. 237–255, figs. 3; pp. 323–344, figs. 3, pl. 23. 1942. (New: *Vormela petenyii*)

KRETZOI, M. Kecskék a Magyar Diluviumban. Földtani Közlöny, vol. 72, pp. 259–262; 353–356, pl. 24. 1942. (New: *Capra* (*Capra*) *zimmermanni*)

KRETZOI, M. Bemerkungen zum System der Nachmiozänen Nashorn-Gattungen. Földtani Közlöny, vol. 72, nos. 4–12, pp. 310–318, 1942. (New: *Acerorhinus* for *A. zernowi* (Borissiak), *Shansirhinus*, *S. ringströmi*, *Procerorhinus* for *Rhinoceros hemitoechus*, *Pliodiceros* for *Colodus* (*Diceros*) *pachygnathus*, *Iranotheriinae*, *Indotherium* for *Teleoceras fatehjangense* Pilgrim, *Sinorhinus* for *Rhinoceros oweni*)

KRETZOI, M. Eomellivora von Polgárdi und Csákvár. Földtani Közlöny, vol. 72, pp. 318–323, pl. 22. 1942. (New: *Eomellivora hungarica; nomen nudum* in Kadic and Kretzoi, Mitt. u. Höhlen—u. Karstforsch., Jahrg. 1930, p. 48)

KRETZOI, M. Präokkupierte und durch ältere zu ersetzende Säugetiernamen. Földtani Közlöny, vol. 72, pp. 346–350, 1942. (New: *Capra libanotica*, *Capra adametzi; Stephanorhinus* for *Rhinoceros etruscus* Falconer, *Mustela* (*Lutreola*) *lutreola ehiki*, *Canis spelaeoides*)

KRETZOI, M. Zwei neue Agriotheriiden aus dem Ungarischen Pannon. Földtani Közlöny, vol. 72, pp. 350–353. 1942. (New: *Agriotheriinae*, *Agriarctos*, *Agriarctos gaali*, *Agriarctos vighi*)

KRETZOI, M. Der Moschusochs in Ungarn. Földtani Közlöny, vol. 72, pp. 357–363, pl. 25. 1942. (New: *Praeovibos*, *P. priscus*)

KRETZOI, M. Die Fauna der Mexico-Höhle bei Diósgyör im Bükkgebirge (Ungarn). Földtani Közlöny, vol. 73, nos. 1–3, p. 18. 1943.

KRETZOI, M. *Kochictis Centennii* N. G. N. Sp., ein Altertümlicher Creodonte aus dem Oberoligozän Siebenbürgens. Földtani Közlöny, vol. 73, nos. 1–3, pp. 190–194. 1943. (New: *Kochictis*, *K. centennii*, *Caniformia*, *Paroxyclaenidae*, *Kochictidae*, *Didymoconidae*, *Dyspternidae*)

KRETZOI, M. Gobitherium n. g. (Mamm. Rhinoc.). Földtani Közlöny, vol. 73, nos. 1–3, pp. 269–272. 1943. (New: *Gobitherium* for *Baluchitherium mongoliense;* Iranotheriinae)

KRETZOI, M. Ein neuer Muscardinide aus dem Ungarischen Miozän. Földtani Közlöny, vol. 73, pp. 271–273. 1943. (New: *Pentaglis*, *Pentaglis földvarii*, *Graphiurinae*, *Leithiinae*, *Glirinae*)

KRETZOI, M. Bemerkungen über Petényia. Földtani Közlöny, vol. 73, pp. 607–608, fig. 1, 1943. (New: *Petenyia neglecta*)

KRETZOI, M. Bemerkungen über das Raubtiersystem. Ann. Hist.-Nat. Mus. Nat. Hungarici, Pars Mineral., Geol. et Palaeont., Budapest, vol. 38, no. 4, pp. 59–83. 1945. (New: *Creophaga*, *Feliformia*, *Ictidailurus*, *Nimravinus*, *N. sectator*, *Hynaenoidea*, *Canioidea*, *Ursavinae*, *Frickodon ursavinus*, *Protarctos* for *Ursus böckhi* Schlosser, *Anictis* for *Viverra simplicidens* Schlosser, *Brachictis* for *Proaelurus medius* var. *crassa* Teilhard de Chardin, *Proaeluridae*, *Quercygale* for *Viverra angustidens*, Filhol, *Quercygalidae*, *Proaeluroidae*)

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COMMENT AND NEWS

COMMITTEE ON INTERRELATIONS OF PLEISTOCENE RESEARCH

The Committee on Interrelations of Pleistocene Research, of the Division of Geology and Geography of the National Research Council, met in New Haven April 5–6 (Science, vol. 107: 442–43, April 30, 1948).

The objective of the committee is to prepare a report on the lines of research now being carried out, and to suggest problems that should be attacked.

No group of workers is more keenly concerned with vanishing species, with evolution, and with vertical and horizontal distribution of vertebrates than are the mammalogists. Those who are interested in both Recent and Pleistocene mammals are asked to send suggestions of problems and accounts of the projects on which they are working to *Claude W. Hibbard, Museum of Paleontology, University of Michigan, Ann Arbor, Michigan.*

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